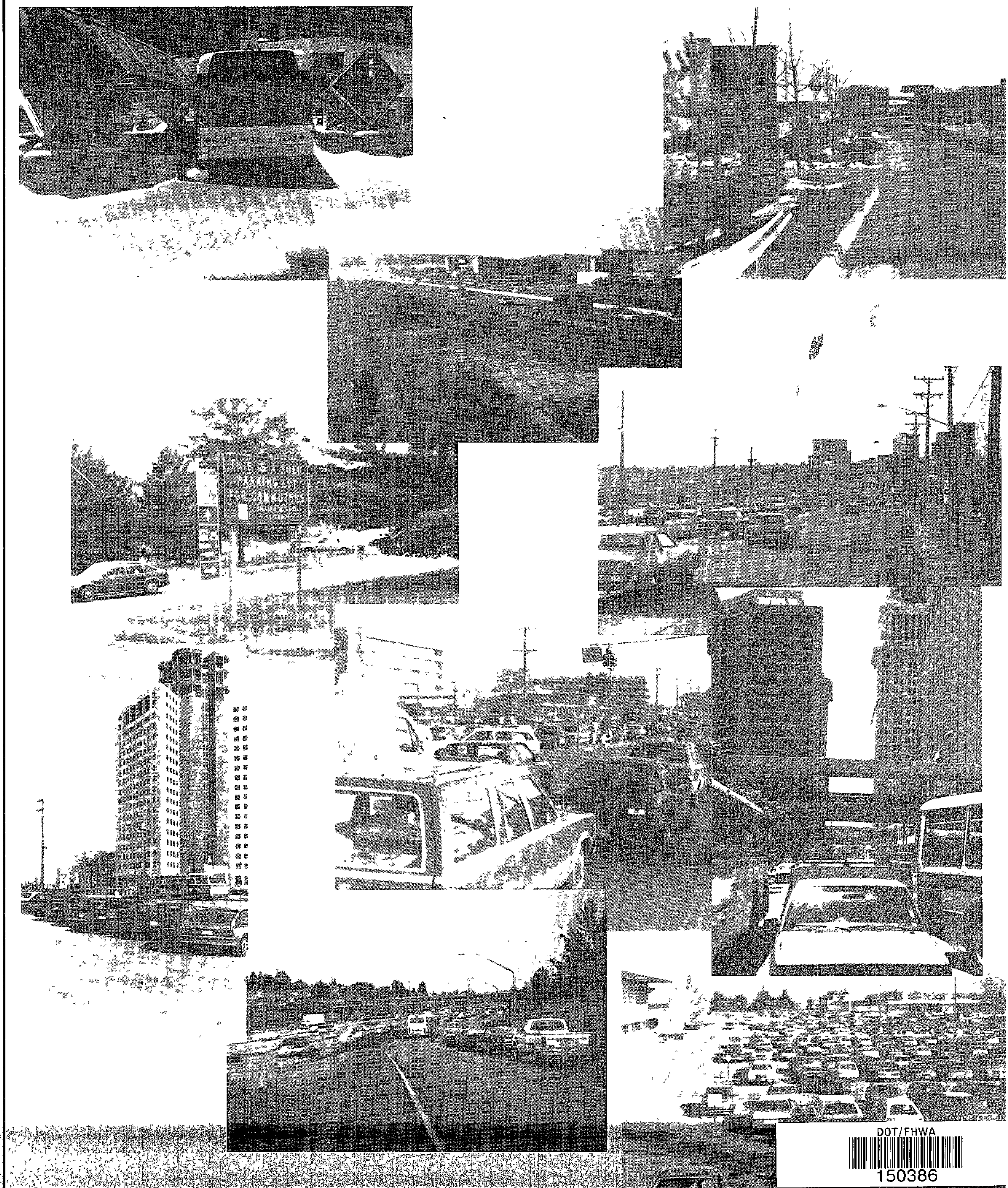
U.S. Department of Transportation

TRANSPORTATION MANAGEME
FOR CORRIDORS AND ACTIVITY
CENTERS: Opportunities and Experiences



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TRANSPORTATION MANAGEMENT FOR CORRIDORS AND ACTIVITY CENTERS: Opportunities and Experiences

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INTRODUCTION

Cost-effective transportation management can improve mobility. Mobility and how to maintain it becomes particularly critical when you consider that traffic on our roads is estimated to increase nearly 50 percent by the year 2000. Our road supply will only increase by about six percent by the year 2000.

The objective of transportation management is to apply cost-effective measures to address the supply/demand problems. The case studies presented in this report illustrate how specific problems were addressed through better management or use of the services, modes, and facilities available. Thus, transportation management attains its goal of mobility through capacity improvements (supply) and demand-reduced actions.

As the concept of transportation management evolved over the last decade, a significant approach has been the establishment of management teams to coordinate, plan, package, and promote transportation management. These teams include the Traffic Management Task Force in Chicago and the Corridor Management Teams throughout Texas. It is the involvement of the public and private sectors with these management teams that has repeatedly led to successful transportation management programs. This same management team approach is also being established to develop cost-effective traffic management plans for major highway reconstruction projects.

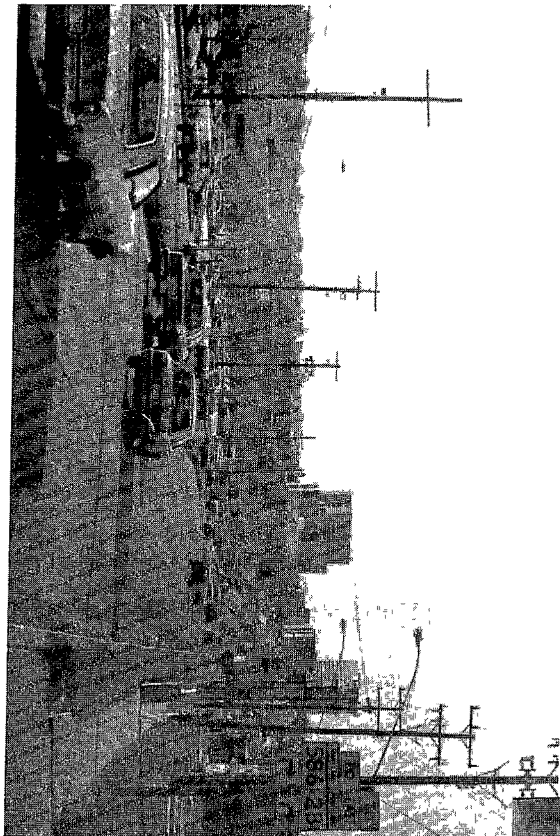
The task of applying cost-effective measures to a problem situation is the real challenge facing both the public and the private sectors. As transportation management plays a greater role in the transportation plans of a region, the need for technical assistance to ensure the effectiveness of the plans will become greater. The opportunities and experiences presented in this publication demonstrate a few of the more successful transportation management strategies used to address urban transportation problems.

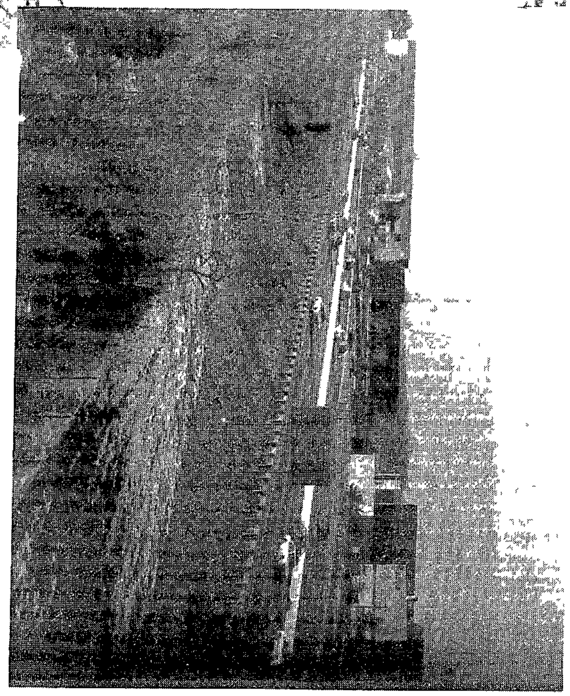
This report consists of two sections, **TRANSPORTATION MANAGEMENT FOR CORRIDORS and TRANSPORTATION MANAGEMENT FOR ACTIVITY CENTERS,** that describe transportation management experiences in the United States.

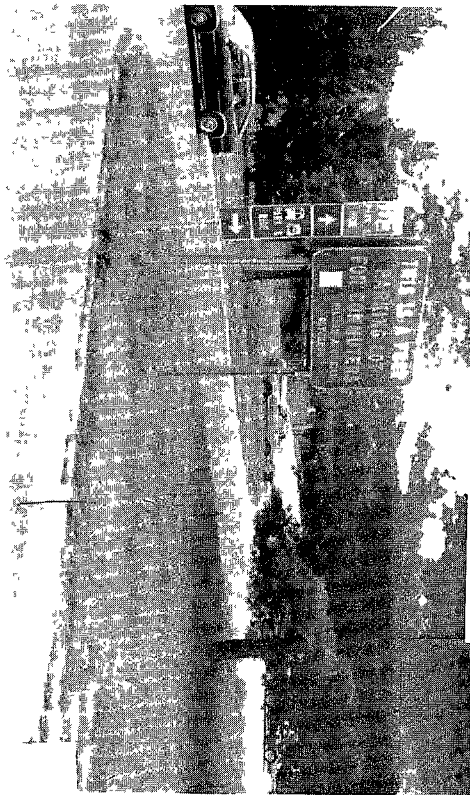
Case studies are the focus of each section. The case studies selected for presentation represent projects considered by the staff of the Planning Analysis Division, Federal Highway Administration, to be practical as well as ones representing a creative approach to improved efficiency. Many of the projects described were funded through the Comprehensive Transportation System Management and National Ridesharing Discretionary Programs initiated in 1979.

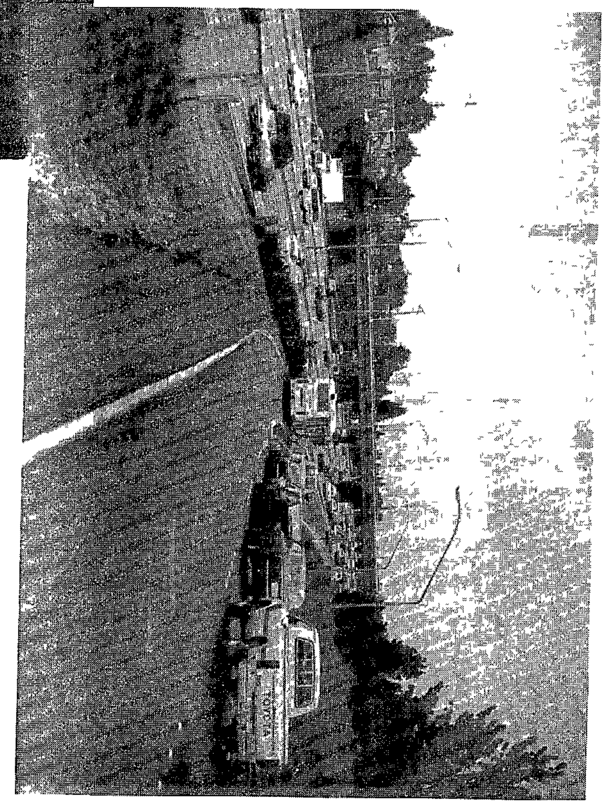
TRANSPORTATION MANAGEMENT FOR CORRIDORS presents opportunities and experiences for efficiently managing the movement of people and goods within both freeway and arterial travel corridors. These actions include preferential treatment for high occupancy vehicles, improved traffic signal coordination, fringe and corridor parking facilities, enhanced transit service, and ridesharing programs. The case studies document experiences in exploiting these actions, either individually or as a combination of several actions, to achieve a level of efficiency. Experiences in effectively addressing traffic impacts of major highway reconstruction are included.

TRANSPORTATION MANAGEMENT FOR ACTIVITY CENTERS includes opportunities and experiences for major urban concentrations such as a central business district (CBD) and major developments in suburban areas. Activity centers as major trip generators can include locations for employment, retail, commercial, or special event activities. The actions presented are the establishment of traffic engineering and signal improvement programs, parking management programs, pedestrian and transit malls to encourage transit use and facilitate pedestrian movement, transit service improvement programs and employer-based ridesharing programs.









TRANSPORTATION MANAGEMENT FOR CORRIDORS

Opportunities

Application of transportation management strategies to transportation in a corridor can do much to manage the movement of people and vehicles especially during peak period traffic or during major roadway reconstruction. Applied in conjunction with new commercial development, transportation management strategies can provide for increases in travel demand without comparable increases in roadway capacity. Overall, a strong transportation management program in a corridor includes implementing capacity improvement strategies like traffic signal systems and high occupancy vehicle (HOV) lanes along with demand modifying strategies like employer-based ridesharing programs and park-and-ride lots. Experience has demonstrated the effectiveness of transportation management strategies in a corridor situation. It is important to note that while transportation management strategies are effective on an individual basis, the combination of several strategies in a traffic management program can enhance the effectiveness of people movement in a corridor.

This section briefly describes transportation management strategies and their effectiveness when applied to a freeway or arterial corridor situation. Specific case studies are then presented as illustrations of the application of one or more transportation management actions within a corridor.

Traffic Engineering Improvements

Traffic engineering improvements such as traffic channelization, left/right turn lanes, one-way streets, reversible traffic lanes, intersection widening, bus turnout bays, and improved signing and pavement markings are the most widely implemented transportation management actions in corridors, especially those with major arterial roadways. Based on experience in small, medium, and large communities, capacity has increased by 15 percent and safety (usually a reduction in vehicle accidents) has increased by 20 percent due to these improvements. Because of the nature and scope of use, the cost of these improvements varies considerably, but the benefits usually exceed the costs involved in implementing them.

Traffic Control Systems

Traffic control systems are designed to reduce travel times, delays, stops, and improve average speeds on arterial roadways and freeways. These systems include actions like coordination of traffic signals, continuous updating or optimizing signal timing plans, computer-based traffic signal control, bus priority signal systems, and freeway traffic management. Typical experiences have shown at least a 10 percent decrease in travel times and vehicle delay on arterials as a result of improved traffic signal systems. The use of ramp meter signals on freeways can smooth traffic flows and improve freeway speeds by approximately 20 percent.

Priority Treatment for High Occupancy Vehicles

The term "high occupancy vehicle (HOV)" has come to mean carrying two or more people in a bus, carpool, or Vanpool. On freeways and arterials, priority treatment is achieved by designating a new or existing lane(s) for the exclusive use of HOV's usually during peak commuting periods. Communities that provide priority treatment to HOV's can increase the people carrying capacity of congested freeways and arterials, defer the need to construct additional roadway capacity, improve the efficiency and economy of pubic transit and ridesharing operations, and provide a time and cost incentive for commuters to rideshare or take public transit. The extent of travel time savings varies depending on the length of the HOV lane, level of use, and congestion in adjacent lanes; however, time savings of 2 to 12 minutes on HOV lanes have been realized. Increases in auto occupancy along a particular corridor have been in the range of 4 to 5 percent as a result of these lanes. Bus service reliability and patronage increases have also been realized because of these lanes. A higher level of priority treatment is provided to carpools, Vanpools, and buses by HOV lanes that are physically separated from normal traffic lanes.

Ramp bypass lanes for HOV's, in coordination with freeway ramp metering, are used as part of a freeway traffic management system to allow HOV's to go around the traffic signal used for ramp metering and enter the freeway with little or no delay. The travel time savings for HOV's in this application can be at least 1 to 2 minutes. In addition, the ramp metering of non-HOV's can reduce congestion, increase vehicle occupancy levels, and improve safety on the freeway.

Fringe and Corridor Parking Facilities

Fringe and corridor parking facilities serve to shift parking supply from the downtown/activity center to the outlying area, reducing congestion and vehicle travel demand through a corridor. Similarly, these facilities are intended to increase parking supply, shift demand to outlying low density areas, and encourage commuters to use public transit or rideshare. These parking facilities are usually owned by city, county, and/or State transportation agencies; however, they can also be leased by a public agency from a private organization (such as a shopping center or church) that has available parking spaces during daily commuting hours. These parking spaces are often provided free, but when a fee is involved, it is usually in the range of $1-2 per day per parking space.

In the Hartford, Connecticut, area there are over 30 lots served by express bus and over 80 lots used as carpool staging areas. The park-and-ride lot utilization ranges from 45 to 64 percent. In Portland, Oregon, nearly 2,000 vehicles per day use over 70 lots that are generally leased from or donated by churches and shopping centers but provided free to commuters.

Transit Service Improvements

In a corridor application, transit service improvements include express bus service, bus transfer centers, more frequent runs, and limited stop bus routes. It is important to note these improvements can be further enhanced when actions like preferential lanes, signal priority, and ramps for buses and park-and-ride lots are also applied to enhance transit service in a corridor. The basic goal of these improvements is to make transit an attractive alternative to driving alone by providing reliable and frequent service and some degree of travel time savings.

Bus transfer centers provide a point where several routes in a corridor converge with coordinated "timed" schedules to permit transfers to other line haul or feeder routes with a minimum of waiting time. These centers can improve the frequency of transit service along corridors while providing a broader area of coverage, especially in less dense suburban areas. Portland, Oregon, is a good example of a community where the use of transfer centers has enhanced transit operations. These transfer centers can also be used to coordinate transfer between modes such as bus, taxicab, and rail service.

Corridor Ridesharing Programs

Corridor ridesharing programs, including carpooling, vanpooling, and buspooling, are aimed at reducing vehicle demand while increasing vehicle occupancy rates in a corridor. This strategy is especially important in congested arterial or freeway corridors with limited potential for building additional vehicle lanes. These strategies are also important during periods of major bridge or roadway reconstruction where vehicle roadway capacity is reduced, but existing person travel demands must be accommodated. Preferential lanes and ramps as well as parking facilities have provided significant incentives to ridesharing. Variable work hour projects have also been used to facilitate ridesharing activity.

Corridor ridesharing programs have been most effective when implemented in cooperation with major employers or developers who wish to establish ridesharing programs at specific sites. These sites have high employment concentrations and are usually commercial, manufacturing, or retail activity centers in surburban and downtown areas. Specific corridor management ridesharing programs include employer-based efforts, corridor-wide carpool matching services, highway informational signs, and corridor-wide promotions.

Experiences

Freeway Management Interstate 5 (Seattle, Washington)

The problem of traffic congestion is characteristic of most urban freeways, especially during the commuting periods. With restraints on unlimited expansion of freeway facilities, attention has focused on the concept of managing the use of the freeway to increase the mobility of people and improve the flow of vehicles. Actions such as designating special lanes for Carpools, Vanpools, or buses; establishing express bus service; installing ramp metering devices; and implementing corridor ridesharing programs have to some degree been used as freeway management projects. Freeway management actions also become important transportation measures to accommodate the growth in travel due to commercial or residential development in the corridor.

In the Seattle area, the Washington State Department of Transportation (WSDOT), working closely with the city, and the transit operator (Metro), implemented a comprehensive package of freeway management actions along I-5 North (north from Seattle). The package included preferential lanes for HOV's, a ramp metering system with HOV bypass lanes, express bus service with selected freeway stops, a corridor ridesharing program, and a strong civilian assisted enforcement program.

This freeway management program demonstrates how implementing a package of actions can be an effective way to improve person and vehicle movement in a corridor as opposed to implementing only a single freeway management action. The I-5 freeway management project is presented as an example of how a package of actions can be implemented in a corridor to improve the capacity of the facility for moving people and vehicles.

The Flow Program is a package of freeway management actions used by the WSDOT to improve person and vehicle movement along I-5. The Flow Program has enabled WSDOT to maintain a viable freeway operation without the expensive construction of new facilities. The program packages the following actions for freeway management: high occupancy vehicle lanes (HOV-known as the "Fast Lane"); a ramp metering system with bypass lanes for HOV's; designated stops for transit (known as the Freeway Flyer Stops); park-and-ride lots; and a civilian assisted "Fast Lane" enforcement plan. The Flow Program, in conjunction with programs like reduced carpool parking fees, variable work hours, transit service improvements, and vanpool incentive actions, provides a realistic package of actions to maintain mobility through the I-5 Corridor in the future.

The WSDOT had three primary objectives for implementing the Flow Program:

1. to improve I-5 freeway operating efficiency, in order to save time and money.

2. to reduce merging and congestion related accidents.

3. to maximize the people-moving capability of the freeway through on-ramp metering and HOV lanes.

Each of the major actions in the package, aimed at meeting these objectives, are presented in this case study.

1. Ramp Control: The ramp metering system on I-5 began in September 1981. It controls 13 southbound on-ramps during the a.m. peak period and five northbound ramps during the p.m. peak period. The ramp metering system allows vehicles to enter the freeway one at a time, in order to reduce merge problems and to smooth out platoons of vehicles entering the freeway.

The morning peak period extends from 6:00 a.m. to 9:00 a.m. In the southbound direction for the morning peak period, the ramp metering system operation is flexible. For the northern-most ramps, operation begins between 6:20 a.m. and 6:45 a.m. depending on traffic conditions. On the ramps closer to the downtown, metering operation begins between 7:00 a.m. and 7:15 a.m. Ramp meters are usually turned off between 8:00 a.m. and 8: 15 a.m. Flexible turn-on and turn-off times for the ramp metering signals allow the traffic engineer to produce optimum freeway operation within existing conditions. The afternoon peak period extends from 3:30 p.m. to 6:30 p.m. All ramp metering signals are generally turned on between 4:00 p.m. and 4:20 p.m. and then turned off between 5:50 p.m. and 6:10 p.m., depending on traffic conditions.

Delays at metered ramps averaged less than 3 minutes per vehicle during the a.m. and p.m. peak periods. During a period of about one-half hour in the morning peak, maximum delays of 5 to 8 minutes occur on three of the northern most ramps.

The overall on-ramp volumes decreased following the implementation of ramp metering. During the first year of metering the on-ramp volume decreased an average of 25 percent during the a.m. peak period. During the second year of operation, volumes stabilized at the first year's level. Some of the reasons for such a dramatic decrease during the first year of metering were: route diversion to avoid the ramps and freeway (especially for short trips); trip time changes to avoid ramps when queues exist during metering; travel mode changes from drive alone to buses, Carpools, and Vanpools; and, elimination of trips taken during peak periods.

At selected on-ramps with meters, an HOV bypass lane was added to allow HOV's non-metered access to the freeway, thereby avoiding ramp queues. There are bypass lanes provided at six locations in the southbound direction for the morning peak period. Only one bypass lane is provided at a ramp meter in the northbound direction for the afternoon peak period. In addition to the HOV bypass ramps, two exclusive HOV ramps are provided to and from I-5 in the downtown area.

2. Variable Definition of Auto Occupancy: An innovative element of the I-5 Flow Program is the application of a variable occupancy definition for an HOV at the ramp meter bypasses. At eight of the ramps the definition of a carpool is 3 persons. At five ramps, including the two exclusive ramps, the definition of a carpool is 2 persons.

There were three primary objectives in varying this carpool definition. These were: 1) to maximize the efficiency of the HOV bypass lanes by improving total vehicle throughput; 2) to attract more commuters to ridesharing by allowing carpools of two to use the HOV ramp bypass lanes; and, 3) to demonstrate that an HOV facility can operate under flexible carpool definitions with a high degree of public acceptability and without adversely affecting violation rates.

Each of the ramps with the 2+ carpool definition showed an increase in HOV bypass lane volumes over the previous 3 + carpool definition. The increased volume was due primarily to the increase in the number of two occupant vehicles. The volume at one exclusive HOV ramp went from 50 Carpools with 3 + occupants in the peak hour to about 250 carpools with 2 + occupants. The other exclusive ramp also experienced significant vehicle volume increases. At the ramp bypasses, the increase in vehicle volumes varied between 40 and 80 percent. It is important to note that at these locations the total average auto occupancy level actually decreased as vehicle volumes increased. For example, at one of the exclusive HOV ramps the average auto occupancy went from about 2.7 persons per vehicle to about 2.2 persons per vehicle. At one of the bypass ramps, the occupancy went from about 2.4 to about 2.0 persons per vehicle.

There was concern by State and local officials about the potential confusion to the commuters with the variable carpool definition. It was felt that the variable definition was warranted at selected locations due to low use of the HOV bypass lane. Reducing the required number of occupants per vehicle from three to two opened the use of the ramps to a broader range of commuters. It is believed that the relaxed requirements enabled some drive alone people to get into Carpools by virtue of the relative ease of forming a carpool of two persons vs. a carpool of three. Use of the bypass lanes has increased as a result of this change in carpool definition.

In order to evaluate the variable definition with regard to possible motorist confusion, the State project team held meetings with representatives of the court districts responsible for adjudication of the HOV bypass lane violators. Of the violators requesting hearings, very few actually cited confusion about the carpool definition as a cause of the violation. Low use of the lane was sometimes cited as a problem and possible reason for violations. Information from the courts demonstrated that confusion with the variable Carpool definition was not the cause of HOV bypass lane violations. This information also indicates that with the extensive marketing campaign, appropriate lead time and clear signing, the general public was able to adapt to a variable carpool definition.

3. High Occupancy Vehicle (HOV) Lanes: In August 1983, an additional lane was provided in each direction for the exclusive use of high occupancy vehicles: buses, carpools, and vanpools. Motorcycles are also allowed to use the lane. For both directions, the lanes were built on the left most or median side of the freeway. The northbound lane is about 4 miles in length, and the southbound lane is 5.6 miles in length. The lanes are designated as the "Fast Lanes" and have a minimum occupancy requirement per auto of three or more people. Designating the lanes in this manner allows the State and the local ridesharing agency to promote and market the lane as an incentive to ridesharing or use of public transit. The "Fast Lanes" operate 24 hours a day, not just during the peak period.

The lanes were added to the north Seattle corridor of I-5 to address congestion problems and increased people-moving demands on the facility.

The "Fast Lane" carries approximately 400 vehicles per hour during the peak period in the peak direction. This is about 20 to 25 percent of lane capacity. During the peak time, the general purpose lanes operate at or near capacity (approximately 1,800 vehicles per hour). The higher speeds of the "Fast Lane" provide a shorter commuting travel time — an incentive to carpool or take the bus.

The greatest advantage of the "Fast Lane" is the ability to move more people in fewer vehicles on the freeway. During the morning peak hour, as many as 2,800 people use the southbound "Fast Lane." During the p.m. peak hour, about 2,200 people use the northbound "Fast Lane." The average occupancy for the southbound lane is 6.3 persons per vehicle and 5.5 persons per vehicle for the northbound lane (general purpose lane).

4. Effective Enforcement Activity: The threat of high violation rates can endanger the integrity of any facility designed to provide preferential treatment to HOV's. A WSDOT evaluation of the first 3 months of "Fast Lane" operation (August 29, 1983, to December 6, 1983) showed that between 15 to 30 percent of the vehicles traveling in the "Fast Lane" were violators, that is, vehicles carrying fewer than three people. This violation rate existed under the traditional, high cost approach of enforcing HOV lanes by hiring additional law enforcement officers or paying overtime for special emphasis patrols. In an attempt to find a more cost-effective method for reducing the ramp meter bypass and "Fast Lane" violation rates, the WSDOT tested two rather innovative alternatives: 1) a public hot line (764-HERO) and 2) deployment of paraprofessional Department of Transportation observers.

The HERO portion of the enforcement project was patterned after a successful hotline call-in campaign aimed at apprehending bank robbers. The letters H-E-R-O represent the last four digits of the phone number used by the general public to report "Fast Lane" violators. Signs providing the 764-HERO number were installed along the lanes and ramps of I-5 and an extensive public information campaign was undertaken to inform the public of the new program. The WSDOT staff manned the HERO line from 6:30 a.m. to 6:30 p.m. (an answering machine was used from 6:30 p.m. to 6:30 a.m.), obtaining information on violators of the minimum occupancy requirements. Information is obtained from the caller on the location of the violation, the time, the day, the date, the vehicle license number, the vehicle description, the number of occupants in the violating vehicle, and any other pertinent comments.

The caller was not required to provide his or her name when reporting violations. A brochure entitled "Thanks for being a HERO" was mailed to all callers who desired more information about the HERO program. Over 300 brochures were mailed out during the first few months of the HERO program.

The WSDOT staff also collected information on violating vehicles through field observations. These observers recorded information identical to that received via the HERO program. It was expected that this program would provide the majority of the reported violations; however, as the program developed, the number, accuracy and cost-effectiveness of the HERO reports proved to be superior to the WSDOT observers. It was believed that the reason for this was due to the fact that the observers provided stationary reports while the HERO reports came from commuters traveling with violators. The HERO callers had more opportunity to accurately observe and identify violators before making a report.

Once a violation was reported, WSDOT was able to verify the accuracy of the license number and vehicle description through State registration files. Through the State computer files, the WSDOT staff was able to obtain the name and address of the owner of the reported vehicle. If the vehicle description on file matched the description provided by the HERO caller or WSDOT observer, four possible actions were taken:

1. For a first time report, the owner was mailed a brochure explaining the "Fast Lane" enforcement program and describing how that program relates to the TSM activities of the State, the city, and the transit operator. The brochure also contained an application for the rideshare matching program of the transit operator. During the first 4 months, 113 rideshare matching applications were received.

2. If, after 1 week, a vehicle was again reported violating the lane, another brochure was mailed to the violator along with a personalized letter from WSDOT identifying the violation time, place, date, and vehicle.

The letter emphasized the need for compliance with the occupancy requirements.

3. Owners of vehicles reported for a third time received a letter from the State Police informing them that they had been reported by WSDOT as violators of the "Fast Lane." The letter also informed them of the $37.00 fine for the violation if apprehended.

4. If continued violation was reported of a vehicle, the vehicle description, license number, and typical time and place of the violation were sent to the State Police. At their discretion, a State Police trooper attempted to make contact with the violator.

A before and after study of violation rates showed a decrease from 28 percent to 17 percent in violations for a 38 percent decrease in HOV violations overall, including all ramps and the "Fast Lane." It must be realized that one of the significant factors contributing to this reduction was the change in carpool definition from three to two persons on five of the ramp meter bypass lanes. Omitting data from these lanes showed a decrease in the violations rate from 28.5 percent to 19 percent, or about 33 percent.

Observation on the "Fast Lane" before and after the enforcement program showed a 32.5 percent decrease in violations, dropping from 28 percent to 19 percent. Overall, ramp violation rates dropped from 27 percent to 12 percent, for a 55 percent decrease after implementation of enforcement activity. For the ramps with the three persons minimum carpool requirement, the violation rates decreased from 30 percent to 18 percent (a 41 percent decrease). For the five ramps with the two person minimum carpool requirement, the violation rate decreased from 24 percent to 9 percent (a 61 percent decrease).

Over the first 4½ months of the enforcement project (February 14 to June 30, 1984), a total of 4,150 HOV lane violators were reported. The 764-HERO line accounted for 89.5 percent of all reported violations. The WSDOT observers accounted for 8 percent and other sources accounted for the remaining 2.5 percent of the reports. Of the HERO reports received, 84 percent provided accurate license numbers and vehicle descriptions. The WSDOT observers provided accurate information for 77 percent of their reports. Ninety percent of the reports were for first time violators, 7.5 percent of the reports were for second time violators, and 2.5 percent of the reports were for three or more violations.

Generally, public opinion of the enforcement project was positive. Many HERO line callers were pleased that the WSDOT was taking steps to enforce the HOV lane regulations. The WSDOT staff manning the HERO line noted that commuters were acutely aware of their commuting environment, and were eager to share experiences they encountered during their commute. The HERO line provided a mechanism for the public to participate in the enforcement of the HOV lanes. It also provided an outlet for commuter frustration generated by a feeling of helplessness when witnessing HOV lane violations.

Media coverage of the enforcement project was extensive. Local newspapers in particular carried several objective feature stories. There were hints about the "Big Brother" image of the HERO project; however, the information obtained from commuters seemed to dispel this image and support the acceptability of the program.

In summary the Flow Program along I-5 demonstrates a comprehensive, innovative, and effective package of actions designed to make better use of an existing facility. The Flow Program, along with express bus service improvements and additional park-and-ride lots, is providing the necessary capacity to handle future mobility needs in the corridor without extensive additional freeway construction. In the Seattle area, coordination and cooperation between State and local agencies led to the success of the Flow Program. The early involvement and subsequent support of the media and the public also played a key role in the success of the effort. Perhaps the biggest lesson to be learned from the I-5 Flow Program is that a comprehensive package of actions can work to foster ridesharing and transit activity as well as meet overall mobility needs in a congested corridor. Individual actions in a comprehensive program reinforce each other to provide a coordinated impact on mobility that is greater than the impact from any single action.

Major Highway Reconstruction (Pittsburgh, Pennsylvania, and Boston, Massachusetts)

Over the next decade many urban highways and bridges will undergo extensive and much needed reconstruction. This will be particularly true in light of the recent 5 cent gasoline tax increase and the Federal Highway Administration's 4R program. This intensive reconstruction effort will have serious impacts on existing traffic flow, particularly in heavily traveled urban freeway corridors.

On a transportation facility operating at or near capacity, the impacts of the reconstruction project will be felt throughout a corridor. In the past, traffic overflows were handled simply by diverting trips to nearby arterials which had excess capacity by designating certain alternative routes. Not much thought was placed in modifying vehicle and person demand. However, most urban corridors no longer have the excess capacity needed to handle the demand. What is needed today is a program of measures that do not simply shift demand, but reduce demand through the corridor. The goal of this type of comprehensive approach is to maximize both vehicle and people moving capacity in the corridor during reconstruction.

The application of transportation management improvements to this problem could prove to be very cost-effective. Transportation management techniques can be used to manage or divert vehicle flow from the section being reconstructed, improve traffic flow through the corridor, reduce overall travel demand, and shift demand to currently underutilized modes and services, e.g., transit and ridesharing. Thus, it is essential that an effective mitigation program take into account all travel modes, services, and facilities in a corridor. This "corridor management" approach can incorporate a variety of transportation management measures:

1. Preferential high occupancy vehicle facilities (for example, contra-flow or reversible bus lanes).
2. Park-and-ride lots.
3. Traffic signal improvements.
4. Carpool/vanpool programs.
5. Flextime programs at employment sites to promote travel outside of the peak.

The following case studies describe some recent operational experiences of the application of transportation management measures to mitigate the adverse impacts of major reconstruction in Pittsburgh, Pennsylvania, and Boston, Massachusetts.

Pittsburgh, Pennsylvania-I-376, Parkway East

In March 1981, the Pennsylvania Department of Transportation (PennDOT) undertook a 2-year, $62 million reconstruction and safety update of a 6.5 mile section of the heavily traveled I-376 (the Parkway East) in Pittsburgh, Pennsylvania. The project included concrete pavement overlay, rehabilitation of 21 bridges, lighting and ventilation for a tunnel along the route, new roadway lighting, improved signing, placement of a concrete median, and other safety features.

The 6.5 mile section of the Parkway that was being reconstructed normally carried over 130,000 vehicles per day. For the 2-year reconstruction period, on-ramps at four interchanges along the 6.5 mile section were closed. In the first construction season, March 1981 through October 1981, the westbound through lanes were closed and one lane in each direction was provided in the two eastbound lanes. In the second construction season, March 1982 through October 1982, the eastbound lanes were closed and the westbound lanes carried all the traffic. Compounding the traffic capacity problems were the lack of alternate high-speed, high-capacity routes in the corridor leading to the downtown.

In an attempt to mitigate severe traffic congestion in the corridor for Parkway East users, the PennDOT established a planning task force made up of Federal, State, and local transportation planners and engineers to develop strategies to manage "people movement" through the corridor during the reconstruction period. Although many strategies were discussed, the task force established a plan that contained six programs:

- A new commuter rail train called the "Parkway Limited" that operated twice during the morning and evening rush hours between several eastern suburbs and downtown Pittsburgh along existing Conrail trackage.
- A new Vanpool program in the corridor where vans are leased and Vanpools are organized by a third-party coordinator.
- High occupancy vehicle (HOV) ramps at both ends of the reconstruction zone, intended to encourage ridesharing and express bus use.
- Over 20 new park-and-ride lots at shopping centers or churches for use by travelers on express bus and those forming Carpools or Vanpools.
- Ten new express bus routes in the corridor that would be coordinated with new and existing park-and-ride lots.

- Traffic operations improvements along major alternate routes in the corridor (e.g., pavement widening, signal hardware improvements, signal coordination, left-turn restrictions, reversible lanes for capacity no-parking restrictions, and signing and marking improvements). In addition, traffic control by off-duty police officers was provided at 21 critical locations in the corridor.

Of particular importance in this reconstruction effort was the publicity and community liaison and marketing effort carried out by PennDOT. These efforts were intended to inform the commuter and other corridor travelers about the potential for traffic disruptions. This information program involved over 100 community meetings prior to and during the reconstruction, publication of a project map, specific information on the six alternative strategies, and frequent participation in radio and TV talk shows by PennDOT personnel. Special marketing programs and surveys were conducted at employment sites, in order to promote and encourage use of the six strategies.

In order to monitor, evaluate, and adjust traffic management activity in the corridor, PennDOT undertook an extensive before, during, and after data collection/analysis effort. Screenlines were identified from which to gather information on vehicle volumes and classification, auto occupancies, and route diversions. Perhaps the most important data collection came from a user group of travelers in the corridor. A panel of 2,300 Parkway users was identified through response to a mail-back card which was distributed along the Parkway East. The panel was subsequently contacted by mail before, during, and after the project with questionnaires to identify their responses to the reconstruction and the various alternative TSM strategies.

As a result of the reconstruction, travel on the 6.5-mile section of the Parkway East dropped by two-thirds, to about 40,000 vehicles per day. The average travel time increased 10 minutes on the Parkway East and about 6 minutes during peak periods on the six designated alternate routes. As expected, the primary traveler responses to the reconstruction included changes in route choice and earlier departure times for work. There was a measurable increase in vanpooling in the corridor. With the traffic operations improvements, the roadway system in the corridor was able to accommodate a major change in traffic patterns with some increased congestion but without massive traffic jams.

The effectiveness of each of the strategies is summarized as follows:

- The "Parkway Limited" service carried an average of 250 passengers per day with an average cost per passenger trip of over $20. The average fare paid was $1.90 per trip. Because the rail service offered no real time advantage over the auto, van, or transit and because of the expense of service to PennDOT and the users, ridership declined over the first construction season. Service was finally terminated after 182 days.
- Over 300 people used the new vanpool service. The cost per person trip was about 23 cents, the lowest of any strategy. The participants contributed to the costs of operating the Vanpools through a monthly fee, while the costs to PennDOT were only for organization and startup. The costs to PennDOT decreased during the second construction season even though more vans were added. A large portion of the vanpoolers were previous transit users. Many of the vanpools continued operation after the construction was over, representing a permanent direct reduction in traffic volume and a market for ridesharing activity.
- The park-and-ride lot activity depended on the activity of the other strategies, particularly transit, vanpooling, and carpooling activity. Two-thirds of the users rode transit, and the remainder formed carpools and vanpools. The lots handled about 660 person trips per day, representing 235 vehicles parked, at a cost to PennDOT of $372 per day. The cost per person trip was about $.57. These costs included leasing and maintenance.
- The HOV ramps did accomplish an improvement in average travel time and an increase in auto occupancy along the Parkway East. This occurred even though the average auto occupancy in the corridor remained about the same. Slightly more than 900 vehicles per day used the ramps at a cost to PennDOT of $636 per day.
- About 1,400 people per day used the 10 new express bus services, representing a direct diversion of 500 vehicle trips from the corridor and about 320 vehi-

cle trips from the Parkway East. About 30 percent of the users came from park and-ride lots, and many came from carpools or other transit services. The first year cost of the service was about $1.7 million, representing a cost per person trip of $4.76. Average fare revenue per person was slightly better than $1.00.

- The traffic operations had a significant effect on capacity by enabling several arterials to accommodate substantially larger volumes at the same or lower overall travel time. The reduced travel times occurred despite the fact that the arterials were generally congested prior to the reconstruction project.

Many of the strategies implemented were mutually dependent on each other. The data on effectiveness showed that the traffic operations improvements, the HOV ramps, and vanpooling were the most cost-effective strategies implemented during the reconstruction project. The new express bus and commuter rail service were generally expensive relative to their incremental effect on corridor congestion. Several of the strategies will have permanent benefits. The traffic operations improvements and the vanpool program will persist, representing permanent improvements in travel time and the level of ridesharing.

The experience of the Parkway East reconstruction project can provide useful insights that can be helpful to other communities contemplating similar efforts. The traffic operations improvements are the most effective means of accommodating diverted vehicle trips. The third-party Vanpool program in the corridor was the most cost-effective strategy implemented for moving people and for initiating more permanent vanpooling opportunities in the corridor after the reconstruction. The HOV ramps were effective in increasing vehicle occupancies along the Parkway East. For the most part, the actions complemented and supported each other. This was especially true for the park-and-ride lots, the transit and vanpooling programs, and the HOV ramps.

The Parkway East project represented the first real attempt at corridor management during reconstruction. The planning task force involved many State, local, and Federal actors who were responsible for identifying problem areas, recommending solutions, and implementing specific actions. Citizen groups and business groups were also actively involved in the planning process. Perhaps the most significant aspect to this project was that it demonstrated how TSM strategies can be implemented to manage travel demand in a corridor when major reconstruction is underway.

Boston, Massachusets: The Southeast Expressway

Beginning in March 1983, the Massachusetts Department of Public Works (MDPW) initiated a 2-year reconstruction project on 8.5 miles of the Southeast Expressway. The reconstruction project consisted of replacing 15 bridge decks, resurfacing the 8.5 miles of roadway, widening and lengthening ramp merge areas, providing emergency turnouts, improving roadway lighting and signing, and repairing serious drainage problems along the roadway.

The Southeast Expressway is the only major facility that connects Boston with the southeastern part of the State. It was designed in the late 1950's to carry an average daily volume of 75,000 vehicles; however, in 1983 the highway was carrying over 160,000 vehicles daily. A rapid transit line runs parallel to the facility. Also in the corridor to serve commuters to Boston are commuter boat lines, two commuter rail lines, numerous public and private bus services, and a regional ridesharing program.

Realizing the major disruption and congestion problems that would occur as a result of the reconstruction project, MDPW planners and engineers undertook a comprehensive effort to minimize disruption. The effort consisted of two major facets. First, because of the importance of the highway, it was desirable to maintain as much capacity on the Expressway during the reconstruction as possible while not hindering the contractor's ability to quickly finish the project. Therefore, it was decided that the six-lane Expressway was to be divided into four sections of two lanes each.

The reconstruction began on the outside two lanes on the northbound side with the remaining two lanes serving northbound traffic at all times. The southbound roadway was divided into two parts with 8.5 miles of barriers. The two lanes between the barriers and the median were reversible lanes: northbound between 1:00 p.m.and 10:00 p.m. The remaining two southbound lanes would serve southbound traffic at all times. When the two lanes under construction were finished, the next two northbound lanes would be closed to traffic and the finished lanes opened to traffic. The same process was applied in the southbound direction. By designing the traffic management scheme in this way, it was possible to provide the same number of lanes in the peak hour during the project as before the project.

The second facet of MDPW activity on the Southeast Expressway was to implement a comprehensive plan of actions to minimize disruption to the highway users as well as manage travel demand in the corridor during this period. The plan consisted of construction projects and operational improvements. The $9 million plan consisted of the following actions:

1. Park-and-ride lots-The MDPW expanded two existing park-and-ride lots, built three more, and leased space for a sixth, adding 1,500 spaces for a total of 3,100 spaces in the corridor. Also parking lots at five commuter rail stations were expanded to provide 300 more spaces.

2. Ridesharing-The existing ridesharing agency in the Boston area established an employer-based ridesharing program in the corridor along with an information center for all transportation options available to commuters.

3. ***Alternate*** routes-Four alternate routes were identified for capacity and pavement improvements. Traffic signal operation improvements were also made at 29 key intersections along these routes.

4. ***Mass*** Transit-Additional rail and bus capacity was provided in the corridor. Agreements were made with private bus operators to provide the peak hour service. Two new commuter boat services were provided.

5. Variable work hours/flextime-The MDPW, in cooperation with the transit agency and the Boston Chamber of Commerce, sponsored a major conference to encourage large employers to implement a variable work hours or flextime program.

6. ***Police*** Enforcement-The MDPW, in cooperation with local police agencies along the Expressway, placed police officers at major intersections in the corridor to enforce traffic regulations and direct traffic as necessary.

7. Local Community Assistance-As necessary, the MDPW provided local communities along the route with funds for special congestion problems that might be created due to the reconstruction. Among the projects were ridesharing assistance, additional traffic police, park-and-ride lots, newspaper advertisements, and shuttle buses.

8. Public Information/Community Liaison-The MDPW started a major public information program on the reconstruction project and the transportation options available. The effort included radio and TV ads, the production of public information materials, slide shows, and holding numerous informational meetings for the citizens and businesses in the corridor.

A comprehensive data collection effort that included traffic counts, license plate surveys, on-board transit ridership surveys, and household mailback surveys was undertaken to determine commuter travel characteristics and community response to the reconstruction project and TSM actions. The following travel responses were noted within the first 3 months of reconstruction.

1. ***Traffic*** volumes--During the first week of reconstruction there were 7,000 fewer vehicles on the Expressway, causing improved traffic flow. As a result, by the third week some vehicles began to return. Overall, the Expressway experienced a 9 percent decrease in traffic northbound, representing about 5,000 vehicles during the hours of 6:00 am. to 7:00 p.m. During this time period the southbound direction experienced about a 3 percent reduction in traffic. During the period 7:00 a.m. to 9:00 a.m. the Expressway travel time decreased by 3 to 4 minutes northbound and 1 to 2 minutes in the southbound direction. The auto occupancy did not change on the Expressway. Traffic volumes on alternate routes increased by as much as 20 percent. Much of this travel increase was spread over the 3-hour peak period and therefore did not create any serious congestion problems. Travel time on the alternate routes actually decreased. Travel by heavy trucks on the Expressway decreased by 600 vehicles 2 months after reconstruction began, while some parallel routes experienced increased truck traffic of about 330 vehicles.

2. Park-and-Ride-An increase in parked vehicles of about 7 percent was realized. Of the commuters parking, the following modes were used from the lots: 14 percent carpooled, 14 percent vanpooled, 13 percent used a commuter boat, 33 percent used bus service, 22 percent used commuter rail, and 4 percent used other means.

3. Commuter Boat-The commuter boat attracted about 40 riders. About 60 percent of these people used their car before the reconstruction.

4. Commuter Buses-Commuter bus ridership increased about 4 percent overall in the corridor.

5. Commuter Rail-Overall, ridership on commuter rail increased about 400 passengers per day while the number of cars parked at stations increased by 200 cars. Ridership in the subway line serving the corridor did not change significantly.

Based on a questionnaire to 6,000 motorists identified in a license plate survey during the first 2 weeks of the reconstruction project, the following traveler responses were noted. Thirty-five percent of the respondents indicated that they had tried alternate means of transportation immediately before and after the reconstruction began. Of these, 25 percent tried the subway, 9 percent tried commuter rail, 11 percent tried express bus, and 7 percent tried commuter boat. Fifty-one percent of these people drove on alternate routes and 5 percent rode as a passenger on an alternate route. Sixty-five percent of the respondents did not change their behavior because of the reconstruction and stayed on the Expressway. The most common commuter response was to try an alternate route.

Based on the experience of the MDPW, seven factors were found to be critical in developing a strategy for minimizing disruptions caused by the reconstruction.

1. Understanding likely commuter responses to different actions and the period of adjustment to those actions.
2. Identifying agency objectives.
3. Maintaining program flexibility, especially if changes in actions are warranted.
4. Providing extensive public information, especially during the period before the reconstruction work begins.
5. Organizing and coordinating the actions of the involved agencies such as the transit agency, the ridesharing agency, the police, and the affected local governments.
6. Providing technical information such as traffic volumes, transit ridership, vehicle occupancy, accidents, and travel time on the Expressway and alternate routes.
7. Planning and analysis for reconstruction to tailor actions to local characteristics, determine specific travel responses, and to respond to specific needs for technical information.

In the Boston case, the most important means of alternate travel was using an alternate route, and the most used mass transit option was commuter rail. Also, the Boston experience showed that a comprehensive community relations/media program is essential to the success of any program to minimize disruption.

Growth of HOV Lanes (Houston, Texas)

Houston, Texas, is an example of how high occupancy lanes, constructed in existing freeway medians, can address current traffic congestion problems in a relatively short period of time. A series of five bus and Vanpool transitways are under construction along with park-and-ride lots and improved transit service. The growth of these freeway median HOV lanes is based on the earlier experience and success of Houston North Freeway (I-45) contraflow lane for buses and Vanpools.

The Houston, Texas, area is currently in a mobility crisis. The freeway network does not approach that of cities of comparable size (over 1 million population). The local arterial street system has inadequate capacity and numerous missing links. Transit service has only recently reached satisfactory performance levels and yet significant expansion is needed. In general, the entire transportation system has not kept pace with Houston's rapid growth and unique development patterns.

To combat this growing problem, a regional transit plan was developed and approved in 1978. It was a joint effort by the Metropolitan Transit Authority of Harris County (METRO), the city of Houston, Harris County, Houston-Galveston Area Council, and the State Department of Highways and Public Transportation (SDHPT) to meet Houston's long-term transit needs. The plan contained the following system requirements:

- To provide a basic level of mobility throughout the region by a greatly expanded local bus system:
- To work with local agencies to develop projects which immediately improve peak hour travel;
- To develop a transit system which provides a competitive alternate to the automobile during peak hour traffic congestion;
- To serve more than just downtown;

- To provide flexible service from Houston's dispersed residential areas to its multiple employment centers; and
- To integrate all transit services into one interwoven system providing flexibility of travel throughout the region.

In 1979, METRO and the SDHPT opened a 9.6-mile demonstration contraflow HOV lane on the North Freeway (I-45N). The contraflow lane operated on a lane borrowed from the off-peak direction. It was estimated that buses and vanpools saved about 15-20 minutes in travel time. Despite the success of the demonstration project, the contraflow lane had to be discontinued due to an increase of traffic in the off-peak direction which was causing delays. A permanent transitway is under construction in the median of the North Freeway as part of the regional transit plan's current S-year program. During its operation, the contraflow lane carried about 4,300 person trips during the peak period and saved bus and Vanpool riders about 22 minutes of travel time to work.

Houston's current 5-year program (1985-1989) is concentrating on three general areas: bus service expansion (new routes and improvements to existing service), bus support facility expansion (bus shelters, maintenance facilities, park-and-ride lots and transfer centers) and regional transitway development for buses and vanpools. Five bus and vanpool transitways, all located in freeway medians, are scheduled to be built and in operation by 1989 to improve travel in and around Houston.

While long term needs for Houston may include the construction of a subway or light rail system, there is a more cost-effective action for providing area residents and employers with relief from traffic congestion problems. METRO and the Urban Mass Transportation Administration have agreed that the construction of five bus and Vanpool transitways in conjunction with other TSM strategies (park-and-ride lots and an active ridesharing program) would be quite effective.

The five transitways will allow high-speed operation of HOV's (buses and Vanpools) without conflict from other traffic. They are designed to transport suburban commuters to the major activity centers in the Houston area (See figure 5 9) and will generally include the following design features:

- One-lane reversible high occupancy vehicle facility (inbound in morning, outbound in afternoon);
- Lane constructed within the existing median of the freeway and protected by concrete barriers;
- A narrow shoulder within the transitway to accommodate vehicle breakdowns, and
- Limited, controlled access points.

A total of 42 miles of transitway are currently under construction on the Gulf, North, and Katy Freeways (includes 5 completed miles on Katy Transitway). An additional 23 miles on the Northwest and Southwest Freeways will soon be under construction. The following is a brief description of the five transitways.

- The Gulf Freeway (I-45S) Transitway will be 15.5 miles long extending from downtown Houston. The estimated cost is $100 million for the transitway, interchange facilities, and related support facilities, such as enforcement equipment. Phases I and II are scheduled to open in late 1986 with completion scheduled for 1987.
- The North Freeway (I-45N) Transitway will be 17.5 miles long extending from downtown Houston. The cost of the transitway and related improvements is approximately $77 million. The first phase is scheduled to be completed in 1985. The second phase is scheduled for 1987.
- The Katy Freeway (I-10W) Transitway will be 11.5 miles long. The estimated cost is approximately $52 million. The first phase of the facility opened in November 1984. The full 11.5 miles is scheduled to open in late 1986.
- The Northwest Freeway (U.S. 290) Transitway will be 13.9 miles long. The cost of the transitway and related improvements is approximately $101 million. It is scheduled for completion in late 1987.
- The Southwest Freeway (U.S. 59S) Transitway will be 9.5 miles long and provide two lanes of travel. Cost of the transitway and related improvements is projected at $103 million. Scheduled completion is in late 1988.

Katy Freeway Transitway

In November 1984, METRO celebrated the opening of its first section of transitway on the Katy Freeway (I-10). The transitway is a permanent one-lane reversible HOV facility. It is located in the median of the freeway and separated from normal traffic by two concrete barriers.

It is one of Houston's more heavily travelled corridors. Along the corridor, there is extensive residential and office development activity in addition to light and heavy industry. The Katy Freeway provides the major east/west movement through Houston. It serves the central business district, is an industrial link, and provides major access to several suburban areas and a major medical center.

Before the opening of the transitway, traffic volumes were increasing at annual rates of 4 percent. The freeway was also operating much of the time with stop-and-go traffic. All future traffic forecasts predicted that the traffic congestion problems along the corridor would worsen and most of the route would experience severe congestion during most of the day.

The Katy Transitway was developed to operate in three phases. Phase I was the construction of the first 5 miles of transitway. The completion of the Katy Transitway is intended to reduce peak period travel time by 5 to 10 minutes. The second phase will extend the transitway another 5.25 miles. Once the third phase is completed, the transitway will extend 11.5 miles.

The transitway is restricted to authorized buses and vanpools only. All vanpools must be authorized by Metro and must meet the following van requirements:

- Be designed to carry eight or more passengers.
- Have minimum insurance coverage.
- Have a valid Texas inspection sticker.
- Have a METRO issued transitway authorization decal displayed.
- Have drivers certified and authorized by METRO.

Related transportation improvements include modification to and expansion of park-and-ride lots, park-and-pool lots for Vanpools, and arterial construction to connect one of the park-and-ride lots and the transitway with local streets.

The construction cost of the first 5-mile section of the Katy Transitway is approximately $12 million. The freeway's maintenance work and other project improvements brought the combined cost to an estimated $26 million. Funding sources include the Federal Highway Administration, the Urban Mass Transportation Administration, the State Department of Highways and Public Transportation, the city of Houston, and the Metropolitan Transit Authority.

By the late 1980's, it is estimated that all phases of the Katy Transitway could be operational. In the peak hour alone, the transitway is estimated to move approximately 4,500 commuters in buses and vanpools. In terms of person moving capacity, this represents the equivalent of nearly two freeway lanes full of cars.

Coordination of Traffic Signals (Sioux Falls, South Dakota)

This project demonstrates how a small urban area designed and implemented a cost-effective method of coordinating traffic signals along arterial corridors. An interesting feature of this project is how the city combined the use of different traffic signal coordination methodologies to achieve a cost-effective, comprehensive traffic control system.

In 1981, the city of Sioux Falls (population 81,300) was in the initial stages of planning to install a computerized traffic signal system along one major arterial route. When this project was discussed at various public meetings, there was concern over providing a high cost improvement within one arterial corridor while neglecting needed traffic signal improvements along other major arterials. As a result, the city directed its efforts toward identifying alternative proposals that would have a broader impact on improving the overall traffic signal system of the city.

After evaluating several alternatives, the concept selected involved upgrading traffic signals along the city's major arterial routes and in the Central Business District. This upgrading involved modernization of traffic signal equipment in order to extend the traffic signal coordination activities. It was felt that such improvements would lead to less congestion at signalized intersections, thus reducing delays, vehicular stops, and excessive fuel consumption.

Some 97 of the city's 102 traffic signals were included in this project. The improvements to these intersections involved the installation of new signal equipment (e.g., new signal heads, poles, mast arms, vehicle detector loops) and the coordination of adjacent signals.

The signal coordination was performed using two methods. The first method involved connecting the adjacent signals with wire, either above or below ground, so that the signal timing at several intersections along the arterial could be coordinated, This method of signal coordination is commonly referred to as hard-wire interconnection. The use of the wire interconnect method permits the establishment of the appropriate split selection (proportion of green time to each traffic movement) at each intersection to allow traffic to flow smoothly along the entire arterial route.

The other method used in Sioux Falls for traffic signal coordination involved the installation of a "clock" unit on the controller at each intersection. These clock units are set using a common reference time and are used to maintain coordinated signal times at each intersection. This method is commonly referred to as time-based coordination. With either of these methods of coordinating signals, the times allocated to the phases at a particular intersection may be changed to reflect the current traffic conditions. The times for the signals at the other intersections are then modified to maintain the traffic flow. In the case of the hard-wire interconnect systems the changes are made automatically to all the signals, while with the time-based coordination system each clock unit must be adjusted.

Because of the relatively higher cost of using hard-wire systems and the desire for a comprehensive system, the city opted for a combination of the hard-wire interconnect and the time-based methods. The typical cost of installing interconnect cable can range from $2-$4 per foot for aerial ground installations to $6-$12 per foot underground. Thus, the cost for hard-wire interconnecting signals along an arterial with intersections at about every ¼ mile ranges from $4,000-$12,000 per intersection. For an arterial with intersections every ½ mile, the per intersection costs are doubled. For time-based coordination, the costs for the clock units range from $1 ,OOO-$2,000 per intersection, with installation costs adding another $l,OOO-$2,000. From strictly a cost standpoint, it is obvious why time-based coordination is an attractive alternate to hard-wire interconnect.

In Sioux Falls, the time-based coordination was used as an interim solution in order to extend the signal system coordination along several arterial corridors. When additional funds are available, the time-based coordination units may be replaced by hard-wire interconnect. The time-based units may then be relocated farther out on the arterial to continue to extend the coordinated traffic signal operation.

To evaluate the effectiveness of the traffic signal improvements, the city conducted several studies along the arterials before and after the implementation of the improvements. These studies provided information on the percent of vehicles stopped, the average delay per stopped vehicle, and total delay time. This information was obtained from vehicles traveling along the arterial routes at different time periods during the day, as well as different days of the week.

The overall results from the comparison of the "before" and "after" delay studies showed an 11 percent reduction in the percent of vehicles stopping and a 17 percent reduction in the amount of delay the vehicles were experiencing. In a year's time, this translates to about 36,000 fewer vehicles required to stop, with a reduced vehicle delay of 437 hours. Based on a 250 work-day year and a fuel cost of $1.25 per gallon, the estimated annual benefits are $77,500.

The estimated annual cost was $62,500 over the 15 year life of the project. Therefore, the benefit-to-cost ratio is 1.24 to 1. The low cost of the time-based approach for signal coordination is the primary reason for the benefits exceeding the cost.

The experience with time-based coordination in Sioux Falls has been positive. Most of the units have been in operation for at least 14 months, with only a few needing repair. The city's experience indicates that the units should be field checked every 6 months to verify proper operation.

The concept of extending coordination between adjacent groups of signalized intersections has proved to be feasible. The city has a policy of eventually extending hardwire interconnect between all intersections. In the interim, however, they have found time-based coordination to be an acceptable alternate solution.

Other cities have experienced significant benefits from traffic signal coordination through low-cost time-based methods. These cities include Beaumont, Texas; Bryan, Texas; Wyoming, a suburb of Grand Rapids, Michigan; Hopewell, Virginia; Philadelphia, Pennsylvania; and Davenport, Iowa.

Corridor Management Teams (San Antonio, Texas; Boise, Idaho; Connecticut-Mianus Bridge; and Los Angeles, California)

Implementing transportation management strategies within a corridor usually requires the involvement of a variety of transportation agencies. Many areas have developed corridor management teams as a logical approach to addressing transportation problems. The use of the team concept is not new. Corridor Management Teams began in the seventies but the concept is just beginning to be actively promoted as an efficient, effective means for reviewing major traffic management issues and implementing solutions that address these issues.

San Antonio, Texas

One of the best known examples of a city using the traffic management team concept is San Antonio, Texas. The team concept was-formally adopted by the city of San Antonio in 1975.

The District Traffic Engineering Section of the San Antonio Department of Traffic and Transportation and the Texas State Department of Highways and Public Transportation established the team's composition. The participating agencies included the City Traffic and Transportation Department, the City Transit System, the Traffic Division of the Police Department, and the State.

Initially, the team's primary objective was to address transportation operational problems within a specific freeway corridor focusing on safety aspects. As the team began identifying transportation issues and developing solutions, their scope broadened. The team's objectives changed and they began looking at ways to maintain and improve the urban freeway system and adjacent arterial streets for the safe and efficient movement of people and goods. The most important by-product that resulted was the development of coordination and communication among all transportation-related agencies.

Neither the city nor the State provided specific operational funds for the activities of the team. The costs were absorbed by each agency represented on the team. In addition, all implementation costs were funded under the appropriate agency's normal budget.

The San Antonio Corridor Management Team exemplifies its ability of problem solving and coordination by addressing a variety of transportation problems. Examples of the types of problems being solved include traffic congestion resulting from special events, inclement weather conditions, or vehicle accidents, and poor coordination of research efforts.

A variety of transportation system management (TSM) strategies are applied in solving the above-mentioned problems, The handling of traffic control plans requires a great deal of coordination. During the construction of a freeway, the San Antonio Corridor Management Team provided the forum for developing traffic control plans and coordination. The team implemented alternative work schedules during peak work hours, coordinated bus routes and schedules, provided alternate routes, and issued information to the public.

The San Antonio traffic management team is a success and continues to operate effectively. Because of its demonstrated success, traffic management teams have been created in other Texas cities such as Beaumont, Corpus Christi, El Paso, Fort Worth, Houston, Lubbock, Midland-Odessa, and Wichita Falls.

Boise, Idaho

The traffic management team concept can apply to smaller cities and towns as demonstrated by Boise, Idaho. Boise, Idaho, has an estimated population of 105,000.

The city of Boise was addressing traffic engineering problems without considering the full impact of the recommended solutions. It was soon discovered that solving problems in this manner sometimes resulted in transferring the problem to another area. For example, an improvement made on the freeway system had a direct impact upon the surface street system within the corridor. At this point, the city decided to address transportation problems in a more comprehensive manner. The Ada County Highway District initiated the traffic management team. The team included representatives from the Ada County Highway District, Meridian and Boise School District, the Meridian and Boise Police Departments and the fire department.

From the initial formation of Boise's traffic management team, it concentrated on solving traffic problems with solutions that had a broader, city-wide impact rather than facility specific problems. This was a result of the size of Boise, the fact that the number of major corridors in the city are limited, and the experience they had to date in addressing transportation issues.

The team's recommendations have resulted in the solutions to a number of city-wide traffic management problems. Some specific transportation system management strategies implemented in solving a number of traffic operational problems include the coordination of signals through a central computer, provisions made at all intersections for safe pedestrian crossings, and the allowance of left turn only on specific streets.

Connecticut-Mianus Bridge

The collapse of the Mianus Bridge on the Connecticut Turnpike west of Stamford in June 1983 is a good example of the team concept being used for the sole purpose of addressing an unpredicted incident. When the bridge collapsed, it left the Interstate System severed at a vital link.

The Connecticut Turnpike in southern Fairfield County serves as a connecting link between New England urban centers and New York City and points west. As much as 20 percent of the traffic is through traffic and 12 percent truck traffic. In addition, the road serves as a major commuter route in an area with a large number of corporate headquarters. The emergency situation created by the bridge collapse called for public information efforts and coordination with a large number of agencies across State lines. Metropool, a ridesharing agency that serves employers located in an area of some 2,000 square miles in southwestern Connecticut and several northern suburban areas of New York City, was called in by the Connecticut Department of Transportation and the Governor's Office to take the lead role in this effort as a result of its ties to large employers and its public information program.

Founded in 1981, Metropool has processed several thousand ridesharing applications and set up more than 100 Vanpools. Six months before the bridge collapse, Metropool had prepared and implemented a contingency plan to deal with a commuter rail strike. As a result, it was able to respond quickly to the unforeseen emergency of the bridge collapse. Metropool immediately established a communications network in accordance with its contingency plans. Relying heavily on the private sector, Metropool established a liaison in each major corporation and brought them together to discuss staggered and flexible work hours. Each afternoon the liaisons were informed of changes in the traffic situation.

Metropool established interagency communications with the New Jersey and New York Departments of Transportation, the Port Authority of New York and New Jersey, and other relevant agencies. The cooperation of these agencies was needed to implement detour schemes at other major junctions in the Interstate network. For example, Metropool established a direct link to the electronic signs at the George Washington Bridge on I-95 at the New York-New Jersey border where traffic could be rerouted to other Interstate highways long before entering the New England Thruway/Connecticut Turnpike.

A 24-hour hotline was established using the carpool telephone number that was on highway signs in the area to advertise their ridesharing services. A direct link to State police headquarters at the site of the bridge collapse allowed up-to-date traffic information and detour information to be supplied to callers. Although Metropool's usual emphasis is on vanpools, during the emergency, carpool formation was a more reasonable temporary option. Usually Metropool handles about 200 calls per month for matching; during the first 2 months of the crisis period, the number of carpool matching phone calls rose to about 500 per month. About 80-90 percent of the bridge-related calls were matched and about 40 percent of these resulted in actual Carpools.

Los Angeles, California

Experience in the Los Angeles, California, area has clearly demonstrated the value of forming management teams to address transportation problems as a result of incidents. The California Department of Transportation (CALTRANS) initiated an incident management team as a result of increased delays on freeways and streets caused by accidents, vehicle breakdowns, and toxic chemical spills. During one calendar year in the Los Angeles region, there were 220 incidents that caused major blockages of freeway lanes.

To make the management teams more effective, Los Angeles also formed incident response teams that are responsible for clearing all incidents as they occur. These teams are comprised of about 24 volunteers, from agencies such as enforcement, traffic engineering, highway maintenance, etc. At every major incident, the response team is involved and calls other agencies (e.g., fire, ambulance, etc.) as they are needed. Teams operate like a volunteer fire department — members take equipment (vehicles, signs, flares, etc.) home, are on call 24 hours a day, and respond to an incident that blocks two or more freeway lanes for 2 or more hours.

No one agency is in charge at the incident. The team has the responsibility of assessing the situation at each incident. Concensus decisions are made concerning the handling of an incident, where to detour traffic, how and when the wreckage will be cleared, etc. As a final step in managing an incident, the response team critiques the operation. Any deficiencies in the system are noted and steps taken to correct them.

In 1984, CALTRANS spent an estimated $85,000 for the response teams. Of that amount, over $30,000 was recovered from those parties that caused the accidents. During the same period, savings to the public resulting from reduced delays totalled over $550,000. The resultant benefit/cost ratio was about 10 to 1.

Traffic Enginneering Assistance Programs (California and Missouri)

Many State highway agencies have established cost-effective programs for providing traffic engineering assistance to local areas. Generally, this assistance is provided to small urban areas that do not have a professional traffic engineering staff. Most of these programs focus on the retiming of traffic signals along major arterial routes. In many cases, these programs were established as part of an effort to save energy through a more efficient traffic signal system.

The purpose of this case study is to describe two such State programs of traffic engineering assistance. The two programs discussed are being operated in California and Missouri. It should be noted, however, that other States have similar programs (e.g., Pennsylvania and Florida).

California

In 1982, the California Energy Commission initiated the Fuel Efficient Traffic Signal Management Program (FETSIM) to provide financial and technical assistance to local agencies responsible for over 80 percent of the traffic signals in the State. The primary goal of this program is to help local traffic engineers develop more effective traffic signal timing plans and thus provide for improvements in traffic flow patterns. In the first year of the program (1983), $2.4 million was approved by the California State legislature to carry out this effort. Funds were allocated to local agencies that had applied for grants.

Two major components of the program were training and technical assistance. The training activities under the program were designed to improve the skills of local traffic engineers as well as traffic consultants that serve the local areas. The training, conducted by the University of California Institute of Transportation Studies with the assistance of the California Energy Commission staff, covered the following areas:

- Principles of fuel efficient traffic management
- Planning and organization of an effective traffic signal management project
- Practical use of traffic signal timing and evaluation tools; including the computer program, TRANSYT (Traffic Network Study Tool)
- Implementation of improved timing plans and continued maintenance of effective signal operation.

Much of the training focused on the use of the TRANSYT computer program, as it was the primary tool used in determining optimal signal timing. Hands-on experience with the necessary microcomputer software and manual signal timing techniques was provided for in the workshop sessions.

The technical assistance component was most evident during the project implementation. This assistance to the local agencies ranged from providing advice on data collection and evaluation procedures to help in setting up, running, and interpreting computer programs. Local agencies without in-house computing facilities were provided access to computers on the Berkeley campus and in State facilities. To coordinate this technical assistance work, centers were established in Berkeley and Los Angeles. Field visits and telephone contact were also used to provide assistance.

During the program's first year of operation, some very impressive results were achieved. Forty-one cities retimed 1,535 signals. These efforts produced a more than 14 percent reduction in stops and delays, a 6.5 percent savings in traveltime, and a 6 percent decline in fuel use. This fuel use reduction translates to an annual savings of about 6.4 million gallons of fuel. Using an average fuel cost of

$1.15 to $1.20 a gallon, nearly $8 million in savings to California drivers was achieved through this program. Further, using estimates for the value of time and costs for vehicular wear and tear, an additional $24 million is being saved by motorists each year.

In 1984, some $1.1 million was made available to local agencies to participate in the program. Twenty-nine cites participated, retiming 1,168 signals. Twelve of these cities were participants during the first year. A third year of the program is currently in operation, with seventeen cities retiming 575 signals. The program responsibility has been shifted to the California Department of Transportation.

Missouri

Another similar traffic engineering assistance program was set up in the State of Missouri. This program was initially established under the National Comprehensive TSM Assistance Program and provided local areas with assistance in retiming their traffic signals. Signal optimization plans were developed for 10 cities in Missouri, representing a total of 161 intersections. In contrast to the on-site computing element of the California program, a central facility was established for maintaining the TRANSYT-7F software that was used to develop the optimization plans. Initially, to generate interest among the local areas, a training course was held to discuss the program. The Missouri program has generated equally impressive results. The State has estimated a cost-benefit ratio of approximately 27 to 1 for the optimization plans that were implemented under the program.

The success of both the California and Missouri programs is obvious. These programs have clearly demonstrated the many benefits that may be derived through traffic engineering assistance to local areas.

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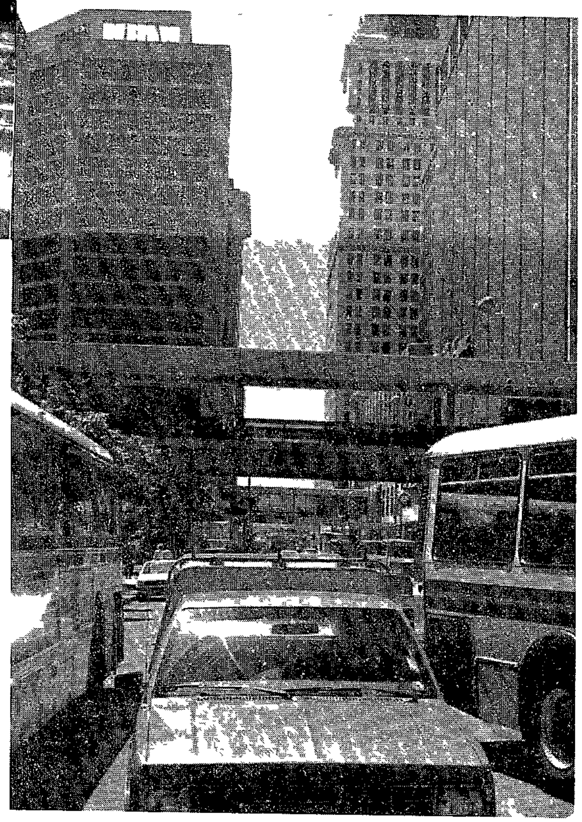
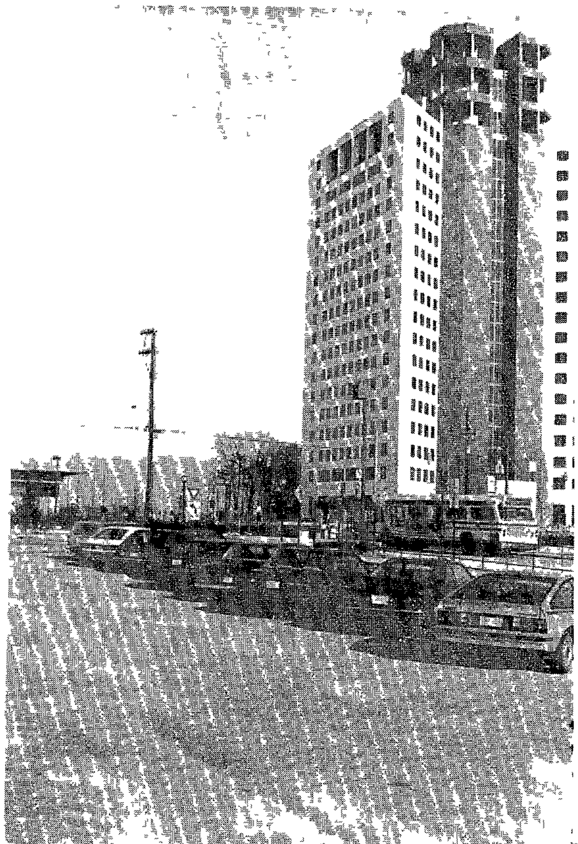
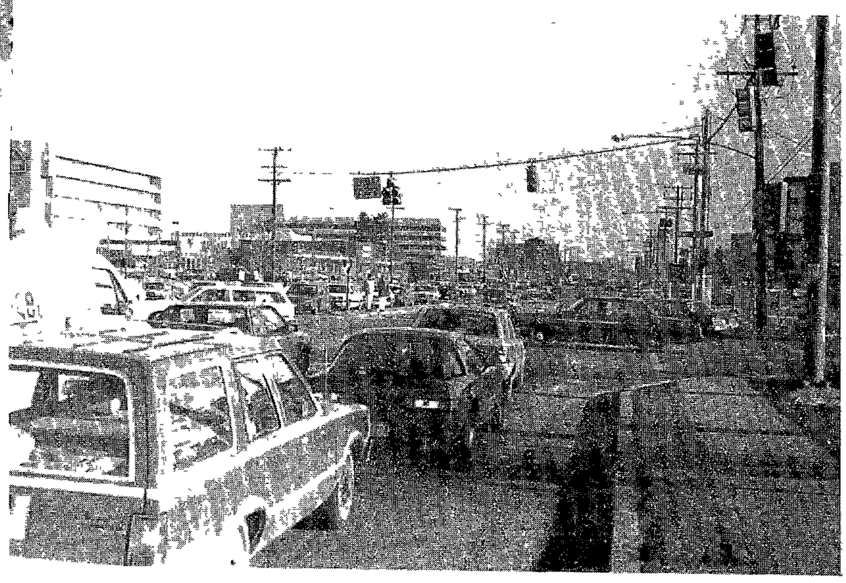

TRANSPORTATION MANAGEMENT FOR ACTIVITY CENTERS

Opportunities

Activity centers are the focus for employment, retail, commercial, special event, and/or recreational trips. For most cities the downtown or central business district (CBD) serves as the major activity center. Today, as cities develop and grow, suburban areas are considered major activity centers containing large commercial, retail, and shopping development. Major sports stadiums, recreational complexes and exposition areas also serve as major activity centers even if not on a regular, daily basis. Activity centers attract a diversity of trips, ranging from work, to shopping, to recreation. Because of this, activity centers provide significant challenges to managing people and goods movement. The overall goal of transportation management strategies for activity centers is mobility.

A wide range of transportation management strategies may be applied to meet the mobility needs of activity centers. These transportation management strategies may include actions to modify roadway supply or actions to modify vehicular demand. Actions to modify roadway supply may increase capacity such as signal improvements or decrease vehicle capacity such as with pedestrian or transit malls. Actions may also be oriented to reducing vehicle demand, which contributes to reducing congestion and enhancing mobility, Such actions may include transit fare programs, preferential lanes for buses, vanpooling, and parking management.

Several considerations are noteworthy when applying transportation management strategies to activity centers:

1. Opportunities exist for private sector participation in the planning, financing, implementation, and operation of transportation management actions, especially for new suburban development sites.

2. Coordination among public services at all stages of development is an essential ingredient to the success of the transportation management actions.

3. By starting with one action that is successfully implemented, the gradual implementation of additional complementary transportation management actions may be realized.

4. With many transportation management actions, monitoring is essential for continued operation, modification, or alteration.

5. Institutional changes in organizations, regulations, laws, and/or ordinances may be necessary to effectively implement the transportation management action(s).

6. Although the scale of the project may vary, transportation management actions can be applied to small, medium, and large cities effectively.

Certainly other political, financial, technical, or social factors may be considered depending on community goals and objectives.

In this chapter, the application of transportation management strategies and actions to activity centers are presented. The specific strategies and their related actions are illustrated. Then, a number of case studies are presented to demonstrate how many of the strategies were actually applied in communities around the country.

Traffic Engineering Improvements

Arterial roadways typically provide the access to and circulation for activity centers. In activity center situations, arterials contain problems such as high numbers of accidents, congestion, outdated design, and conflicting turning movements. For activity centers, traffic engineering actions include traffic channelization, left/right turn lanes, one-way streets, reversible traffic lanes, intersection widening, bus turnout bays, and improved signing and pavement. These have been the most widely implemented transportation management actions, being applied effectively in small, medium, and large cities.

In general, experience with these actions has shown about a 15 percent increase in travel speeds and about a 20 percent reduction in the number of accidents. The nature and scope of use of these actions vary based on city size, problem location and type, and the land-use and transportation goals of the community. It is important to note that when they are applied realistically, the benefits of traffic operations improvements usually exceed the costs of implementation.

Traffic Signal Control Systems

At activity centers, traffic signal control systems are designed to reduce travel times, delays, stops, and accidents and improve speeds on the arterial access and circulation roads. Capacity, safety, and access to new developments are major reasons for the implementation of traffic signal control systems.

The traffic signal control strategy includes actions like maintenance and coordination of traffic signals, continuous updating or optimizing of signal timing plans, computer-based traffic signal control, and bus priority signal systems. The complexity or sophistication of these actions is related to the complexity of the network of arterials that will be affected. Traffic signal maintenance and coordination (with or without the assistance of a computer) is perhaps the most effective action under this strategy. Typical experiences have shown anywhere from a 10 to 15 percent reduction in travel times and vehicle delay as a result of improved traffic signal systems.

Priority Treatment for High Occupancy Vehicles (HOV's)

Priority treatment for HOV's is aimed at encouraging the use of buses, Carpools, and Vanpools by offering a cost, travel time, or walking distance advantage over non-HOV's (e.g., drive alone). At activity centers, the opportunities for preferential treatment include designating curb bus lanes, on-street metered parking spaces for carpools, pricing off-street parking spaces for carpools, and timing traffic signals to allow more green time for buses. Curb bus lanes have been effective in congested activity centers, (e.g., downtowns) by improving bus speeds and schedule reliability about 10 percent.

To be effective from the general public's point of view and from a transit service perspective, bus lanes should carry at least 50 buses per hour. Carpool parking spaces offer conveniences and possibly cost savings as incentives to ridesharing. The preferential signals offer service and reliability improvements for buses as a means to increase ridership. Factors to consider in applying preferential treatments at activity centers include 1) ability to enforce the preferential treatment against violations in use; 2) location of preferential treatment so as to foster HOV use; 3) impacts on non-HOV's; 4) expenditures/savings to implement the preferential treatment; 5) demand or use of the preferential treatment; and, 6) other actions that might reinforce or enhance the operation of the preferential treatment.

Parking Management

One of the most effective strategies for transportation management at activity centers is parking management. The amount of parking provided, the location of parking, the price of parking, how the parking spaces are used, and the local regulations/laws governing the implementation and operation of the parking all have a direct impact on travel behavior. In this regard, parking actions (or nonactions) directly influence the extent of ridesharing or transit use at an activity center and the level of congestion on the arterials in and around an activity center.

Parking management at activity centers includes a wide variety of on-street and off-street actions to meet transportation goals as well as other social, economic, and/or environmental goals. These actions typically include on-street parking restrictions, on-street parking meters (short or long-term), on-street parking enforcement/adjudication programs, off-street parking pricing programs (to encourage short or long-term use), off-street parking discounts in shopping areas, carpool/vanpool parking provisions (both on and off-street), and modifying the parking provisions of local zoning codes to encourage carpool and transit use.

The successful parking management actions are also accompanied by other transportation management actions. For example, parking pricing changes to encourage short-term use may be accompanied by improved transit services such as park-and-ride lots for commuters (long-term users). In successful parking management programs, alternative transportation options are provided when parking restrictions are imposed.

Commuter Bicycle Programs

The objectives of a commuter bicycle program are twofold: 1) to increase the number of people who commute by bicycle in a region and 2) to improve the safety of the bicyclists who commute. It is important to note that such a program is focused **on** bicycling for transportation rather than recreational riding. Bicycling for transportation is distinguished from recreational riding by the fact that transportation riders have a particular destination such as a place of work, school, or shopping.

A commuter bicycle transportation program involves active public-private cooperation to work effectively. The public agency needs to provide the outreach and promotion as well as the actual bike facilities. The employer needs to provide the environment and institutional structure to foster bicycle commuting as an alternative to drive-alone situations. For example, the employer could provide bike lockers, maps, or shower facilities for bicyclists.

Based on some experience with these types of programs, there are four important elements:

1. Production and promotion of a regional bicycle map.

2. An employer program to reach bicycle commuters at the worksite.

3. Public events to generate interest and share information about bicycling.

4. A public information effort to support these activities.

Transit Service Improvements

At activity centers, transit service improvements are aimed at providing reliable and convenient bus operations. In older, more congested downtown areas, where bus volumes are high, special roadway lanes or streets dedicated for use by buses only can improve bus travel times and schedule adherence, especially during peak periods. Other downtown transit service improvements can include fare free zones, bus turnout bays, modified bus stop locations, shopping loop/shuttle service, downtown fringe parking shuttle service, and coordinated transfer operations.

In suburban areas, especially where active development is taking place, transit service improvements can include: special bus lanes (only where bus volumes warrant), timed-transfer terminals, bus turnout bays, shelters, loop/shuttle service between retail and employment sites, buspool programs for employers, and convenient bus stop locations. Other types of transit service improvements at activity centers (especially suburban) can include the use of frequent mini-buses or small demand responsive systems.

With any of these types of improvements a strong effort is necessary to determine where, what, and how best to service the transit market. Once available, promotion of the benefits of the service to the user is critical to the success of the improvement.

Pedestrian Improvements

At activity centers, pedestrian improvements can have several objectives, These objectives can include pedestrian safety, improved mobility, and/or aesthetics. More specifically, the pedestrian improvements are intended to reduce pedestrian and auto conflicts, provide ease of movement for pedestrians, or just provide a pleasant environment for pedestrian activity. The actions under this strategy may include: wider sidewalks, skywalks, pedestrian phase at a traffic signal, rearrangement or removal of street furniture (e.g., sign/light poles and newspaper stands), placement of benches and trees, curb cuts, and improved lighting. These, as well as other actions, serve to make an area attractive for pedestrians. As an area becomes more attractive for pedestrians, retail business usually improves.

One of the most interesting actions has been the skywalks. These elevated structures were originally intended as a means of reducing the auto-pedestrian conflict. In a crowded downtown area, many skywalks are built over streets and connected through marked pathways within the second floor of buildings. Thus, a whole system of pathways and skywalks is developed. Along with this came a second level of retail businesses. The skywalks succeed at improving safety but also improve retail sales activity. The skywalk concept has been used effectively in cities like Cincinnati, Des Moines, Minneapolis, St. Paul, and Duluth.

Malls/Auto Restricted Zones

A mall or auto restricted zone may be implemented to enhance the movement of transit vehicles and/or pedestrians. Implementing this strategy is closely tied with a strategy for transit service improvements and pedestrian improvements. Malls and auto restricted zones may be implemented by totally reconstructing a street or part of streets to incorporate pedestrian and/or transit provisions. They may also be implemented by closing existing streets to autos and allowing pedestrians complete access.

A transit mall represents a compromise between preferential treatment for transit vehicles (e.g., a bus lane) and a full pedestrian only mall. It is a street on which transit vehicles are given exclusive or near-exclusive use, sidewalks are widened, and amenities such as benches, displays, and shelters are added for pedestrians and waiting transit patrons. Access to automobiles is denied or strictly limited, except for cross street traffic. Truck traffic is banned for some if not all hours of the day.

The mall or auto restricted zone is usually created in a congested portion of the city, such as the central business district or shopping district, where automobile traffic is prohibited or restricted. The focal point of the mall or auto restricted zone is a pedestrian or transit enhancement area. In this area, a host of actions may be added including: linear transit malls that extend or connect the CBD to other pedestrian activity centers, reserved bus lanes, transit and taxi facilities, fringe parking lots and garages, special loading docks, internal or feeder shuttle service, and ring roads for rerouting traffic. Cities with completed malls or auto restricted zones include: Portland, Oregon; Denver, Colorado; San Francisco, California; Philadelphia, Pennsylvania; Boston, Massachusetts; and Burlington, Vermont.

Curb Space Management

Curb space is a scarce resource and its uses at activity centers include: general traffic lanes, restricted traffic lane (e.g., HOV's), pedestrian crossing, transit stop, taxi stand entrance, loading zone, and parking. Cities are assessing the need for curb space, and through rationing price and use restrictions, are achieving mobility and accessibility. Washington, D.C., and New Orleans, Louisiana, have achieved curb space management through vigorous on-street parking enforcement programs. The programs serve to relieve congestion while providing additional parking or loading space. Bus operations during the peak periods are also improved. Providing noncongested curb space for improved bus operations is the emphasis of the New York City Surface Transit Enforcement Program (STEP).

Successful curb space management programs have the following key features: the program and its enforcement are under the responsibility of the city traffic engineering department; enforcement is an essential component; and community input is critical to the program. Experience has shown that a curb space management program can help reduce traffic congestion by increasing capacity at peak travel times. Curb space management also has promoted proper use of loading zones and short-term retail-oriented parking. Also, from the public perspective, curb space management can be a revenue generator. Revenues due to enforcement have increased both in Washington and New Orleans.

Ridesharing Programs

Activity centers offer a great deal of opportunity to match commuters into carpools, Vanpools, or buspools. Because of the close proximity of employees, the opportunities to match people into a ridesharing arrangement are increased. The matching activity can be undertaken by a public agency: however, experience has indicated that rideshare matching activity is more effective when the company management is directly involved with employee matching.

With the company management actively supporting ridesharing, other actions can be undertaken to enhance the ridesharing program. These actions include variable (or alternate) work hours, preferential parking programs for rideshare vehicles, and a transit pass discount program. For a local situation, ridesharing programs reduce vehicle demands on arterial streets and the amount that a company needs to invest in order to maintain employee parking, Ridesharing programs need coordination and cooperation between public and private agencies in order to be effective and ongoing. Given that, ridesharing programs have been shown to save a company money while reducing vehicle demands on arterials within the activity center.

Transportation Management Association

A new and effective strategy for establishing ridesharing and transit activity for a major employment area is to establish a transportation management association (TMA).

A TMA is an institutional arrangement among private companies to facilitate the implementation of transportation programs. The TMA's usually establish **some** innovative mechanism to finance transportation such as assessment districts, development impact fees, special purpose taxing districts, and transportation management trust funds. The TMA's generate their own revenues through voluntary assessments, membership dues, and service fees, and with these funds support various transportation activities that respond to the needs of their members. Depending on local requirements, a TMA may assume responsibility for running shuttle buses to a nearby commuter rail station, managing a ridesharing program, administering shared parking, coordinating a staggered work hours program, or instituting a program of local traffic flow improvements.

Certain TMA's have taken on additional functions. They assist their members in discharging traffic mitigation and trip reduction obligations assumed under development agreements; lobby for local transportation improvements with local, county, and State authorities and with transit agencies; and plan for the long-range transportation needs of their members. They become, in other words, a general forum for cooperative public/private transportation decisionmaking.

More than 20 TMAs are already in existence. Some are organized around a single activity center, such as a suburban corporate park or an in-town institutional complex (medical center). Other TMAs are areawide in scope. Some operate their own services, others contract with professional service providers. Some TMAs are single-purpose organizations formed specifically to deal with transportation concerns, while others are parts of broader, multi-purpose organizations which provide a spectrum of services to their members. However, no matter what their form, all TMAs share a common philosophy-they pool private resources in the interest of improving public mobility.

Experiences

Transportation Management Actions for Hospitals and Medical Centers (San Francisco, California and Pittsburgh, Pennsylvania)

Like many employers, hospitals and medical centers are frequently faced with problems of accessibility resulting from traffic congestion and parking supply limitations. In addition, they try to find commuting opportunities for their employees that are attractive and economical. Several actions represent viable solutions to these areas of concern.

Hospitals and medical centers are unique in that they have rotating shifts, a large percentage of part-time employees, and a high employee annual turnover. Successful transportation management actions at medical facilities, as illustrated in the following case studies, address these areas of concern, offering highly workable solutions to transportation related problems.

San Francisco, California

The Children's Hospital of San Francisco is an acute medical care facility located in a predominately residential neighborhood in northwest San Francisco. It employs about 1,400 people. Across the street is Marshal Hale Hospital which has about 500 employees. Nearby, there are two commercial shopping districts. The location of these hospitals caused serious traffic and parking problems in adjacent residential neighborhoods.

Being concerned about hospital-neighborhood relations, Children's Hospital responded to these problems by implementing a variety of actions to alleviate some of the traffic created by the hospital, and thus reduce possible resentment from neighborhood residents. A contractor was hired to assist the hospital in implementing the transportation management actions.

Non-traditional approaches were needed to accommodate rotating shifts, a large proportion of part-time employees, a 30 percent annual turnover rate, and shift changing. An employee survey indicated a 1 ,000-member daily work force divided into three shifts: 77 percent day; 17 percent evening; and 6 percent night. Fifty-seven percent were full-time, permanent; 32 percent were part-time. Fifty-eight percent were driving alone; 15 percent were sharing a ride; 16 percent were using public transit; and 10 percent walked or bicycled. In addition, a parking survey indicated that 390 employee vehicles used on-street parking during the peak.

The contractor recommended a transportation program that included ridesharing, public transit, parking management strategies, and the hiring of a transportation broker to implement the program. A transportation broker was hired immediately.

Rides for Bay Area Commuters and Golden Gate, the local ridesharing agencies, worked hand-in-hand with the hospital to provide the professional support needed to develop, implement, and manage the hospital's program. To get the program started, a marketing campaign was launched that included posters and articles on ridesharing in the hospital newsletter. The hospital cafeteria became the site of a large vanpooling display and a demonstration van from Rides was exhibited to allow employees to experience firsthand the comforts of a vanpool.

To get the employee from the single occupant vehicle, ridesharing incentives were offered. Free parking was offered to carpool groups of three or more employees. Each employee interested in ridesharing was given a matchlist containing names of employees from Children's Hospital, the neighboring institutions, and the businesses in the area. During the orientation of new hospital employees, a lo-minute slide presentation presented commute alternatives.

Flexipools were developed to enable nursing personnel with rotating shifts to rideshare. A group of 15 employees have a designated park-and-ride location. Because of days off, vacation, etc., an average of 8 of the 15 employees usually work on any one day. Whoever shows up before the appointed departure time vanpools that day, with the riders paying the driver a flat rate.

Preferential parking was established for the garage users. Carpools and vanpools of three or more received parking in the garage first. This ensured off-street parking for the carpool and Vanpool participants. A residential parking permit program was established in the adjacent residential areas.

Transit improvements included measures such as monthly transit passes, bus shelters, and a working relationship with the transit agency.

A comprehensive evaluation was conducted of the hospital's transportation program as requested by the neighborhood associations. The results of the report indicated that daily employee auto trips were reduced by 16 percent with long-term, on-street parking being reduced by 42 percent. The employee trips by transit increased from 16 percent to 20 percent. Hospital employees driving alone during the most important shifts-a.m. and p.m. peak hours-decreased from 59 percent traveling alone to 45 percent.

Pittsburgh, Pennsylvania

The Oakland section of Pittsburgh is the home of seven major hospitals and two major universities, including the University of Pittsburgh. In addition, the area contains a number of research institutes, museums, cultural centers, a thriving commercial business district, and well-established residential neighborhoods. As a result, Oakland is considered Pittsburgh's second major activity center, after the downtown area. Over 100,000 people travel to the Oakland area each day to work, shop, visit, and conduct business. Traffic congestion and limitations on the supply of on and off-street parking are recurring problems for the Oakland area.

In 1983, the city of Pittsburgh, responding to numerous neighborhood complaints about parking, implemented a residential parking permit program along streets close to Oakland's institutions. Competition for parking spaces became more intense since the total number of on-street spaces began to decrease. The amount of off-street spaces which the various institutions could supply was also limited due to zoning and available space.

In an attempt to meet the growing transportation demands in the area without further impacts on arterial capacity and parking supply, the seven hospitals of the University Health Center of Pittsburgh (UHCP) and the University of Pittsburgh established a joint program to help Oakland commuters join various kinds of ridesharing arrangements. The purpose of the project was to help alleviate traffic and parking demands in Oakland through the development and promotion of a ridesharing program for employees of UHCP and the University of Pittsburgh. The ridesharing program provided a highly personalized approach to matching candidates into a carpool or vanpool arrangement. The UHCP program offered a low-risk opportunity for employees to start a Vanpool, by sponsoring vans in a third-party (lease) arrangement between employees and the van leasing company.

In order to establish a client data base, a survey was conducted among employees of the UHCP and the University of Pittsburgh. The survey collected information for geographic matching of origins (e.g., street name, municipality, zip code, and telephone) and destination (employer, parking facility used, work telephone number). The work pattern was detailed on the survey to allow for both regular hours, flextime, and rotating shifts. The desired preference for the form of ridesharing (e.g., vanpool rider, driver, carpool rider, driver, etc.) also was requested in the survey for those interested in forming ridesharing arrangements. The survey also obtained information on the level of satisfaction that commuters had with regard to their current means of transportation (e.g., parking, security, service, cost, frequency of operation, and traffic conditions).

In 1982, approximately 7,200 questionnaires were distributed to the UHCP. About 3,600 responses (50 percent) were received with about 1,400 of the individuals indicating they wished to participate in the rideshare program. In 1983, approximately 8,500 questionnaires were sent to the faculty and staff of the University of Pittsburgh. About 1,836 (22 percent) responses were received with about 540 of the people being interested in participating in the rideshare program. The initial database, made up of nearly 2,000 individuals who were driving to work alone, was then put on the mainframe computer of the UHCP to facilitate obtaining information and matching opportunity. Existing carpoolers and public transit users were also contained in this database.

Meetings were held with staff personnel from each UHCP member institution and the University to review the program prior to surveying the employees. Intensive employee awareness campaigns were held with each member institution to acquaint employees with the features, functions, and benefits of ridesharing. Some of these awareness activities were a "Ridesharing Day," brochures identifying parking areas restricted by residential parking permit programs, and a public relations campaign for ridesharing. These promotional activities were believed to be one of the reasons for what was considered a high response rate for the initial survey. Another reason for what was felt to be a positive response to ridesharing was that the program was initiated, developed, and promoted by the major employers in the Oakland area, with only technical assistance being provided by other public and private sector employers.

Through this focused ridesharing effort, about 215 people participated in the vanpool program (about 20 vans). Vanpools were also able to park at most UHCP and University of Pittsburgh buildings. Of the 215 people in Vanpools, 138 previously drove alone, 38 participated in a Carpool, 31 used mass transit, and 8 people used other means. The ridesharing effort also attracted 2,582 people to carpooling, forming about 1,075 carpools. The average occupancy of these carpools is 2.4 persons per vehicle. Of the 2,582 people, 1,500 employees previously drove to work alone, 45 1 were carpooling, 420 used mass transit, and 211 used other means.

Concern over parking and traffic issues in the Oakland area led the employer of the UHCP and the University of Pittsburgh to develop the ridesharing program. As such, ridesharing received management support, enabling over 1,600 employees who previously drove alone to rideshare. The program start-up cost of $165,000 was initially funded as part of the one-time FHWA Ridesharing Discretionary Grant Program in 1981. Because of its success, the program is now supported by other Federal, State, and employer funds.

One of the major lessons learned during the first 3 years of the program is that the success of ridesharing depends on continually contacting both the employers and employees in order to expand the effort to new candidates. These groups were constantly reminded of the ridesharing program and how it directly benefits them. In the Oakland area the benefits included mobility for employees. For employers the benefits meant expansion opportunities without severely impacting existing traffic congestion and a constrained parking supply.

Commuter Bicycle Programs (Lincoln, Nebraska, and Portland, Oregon)

Increasingly, bicycles have been recognized by many cities, States, and regional planning and transportation agencies as a viable and significant method of commuter transportation. No longer is the bicycle solely identified with just recreational use. Lincoln, Nebraska, and Portland, Oregon, are two cities that have demonstrated that the bicyclist is a legitimate road user by constructing bikeways and bike routes for their safe use.

Lincoln, Nebraska

Although the city of Lincoln has recognized the bicyclist as a legitimate road user since 1963, it wasn't until 1974 that the long-range conceptual plan for a system of commuter and recreational bikeways was developed. In 1979, Lincoln's first commuter bikeway, the Billy-Wolff-Antelope Bikeway, was officially opened. This bikeway provides a safe and attractive route for bicyclists commuting to work, to school, to shops, and to other activity centers. The bikeway is 8 feet wide, made of concrete and runs approximately 4 miles from the suburbs to downtown Lincoln.

In addition to the bikeway, there is a 30-mile network of bike routes that are identified by green and white signs. These routes are usually streets which carry a low volume of automobile traffic and provide access to those areas most commonly used by cyclists. Bicycle racks and storage lockers are located near office buildings, stores, and transit stops to help link the bicycle into the transportation system.

To further encourage the use of bicycles as an alternative mode of transportation, the city of Lincoln established the Mayor's Bicycle Advisory Committee. Citizens and representatives of city departments and non-city agencies are on this committee. The committee is charged with supporting bicycling and promoting bicycle safety within Lincoln. This is accomplished by advising the Transportation Department, the Mayor, and the City Council regarding bicycle-related plans and policies.

With an increase in bicycle use, there was the need for several-relatively inexpensive but important bicycle system enhancements. These needed enhancements were as follows:

1. Improve safety at dangerous bikeway/street intersections.

2. Complete various short bicycle facility "gaps," primarily those serving downtown Lincoln.

3. Improve bike route identification to encourage bicycle traffic on safer streets, particularly around the University of Nebraska downtown campus.

4. Encourage the use of bicycles among Lincoln Center businesses as an effective and efficient alternative to the use of automobiles in the downtown area.

Under the U.S. Department of Transportation's one-time Comprehensive Transportation System Management and National Ridesharing Discretionary Programs, the following bicycle system improvements were made to support the growth in bicycle transportation:

1. Construction of a bikeway undercrossing at "A" Street adjacent to the Capital Parkway. Construction consisted of ramps on the north and south approaches to an existing 13 feet high by 35 feet wide box culvert, providing an 8 feet wide riding surface, lighting, signing, and railings.

A similar bikeway undercrossing was completed in 1980 at the intersection of 27th Street. The completion of this "A" Street undercrossing improved the last bicycle crossing of a major street without signal or grade separation protection.

The "A" Street undercrossing resulted in a substantial improvement in safety and convenience for persons commuting by bicycle to the downtown area and encouraged persons to switch from automobile to bicycle for work trips to Lincoln Center.

2. In order to fully accommodate the growing ranks of bicyclists in Lincoln, it was necessary to construct short bikeway segments between existing bikeways and to extend other bikeways to minimize conflicts with motor vehicle traffic. Approximately 5,700 square feet of bikeway construction was completed at 14 different sites in Lincoln to eliminate barriers and improve access for bicyclists to the downtown area.

3. The city of Lincoln has 30 miles of city streets signed as "Bike Routes." The upgrading of signing on 15 miles of local streets and existing Class 1 bikeways was completed. This signing included a series of guide signs which identified major destinations of bicyclists.

4. In order to improve the safety of bicyclists and at the same time avoid unnecessary delay and fuel consumption to motorists, variable message "No Right Turn on Red" signs were installed at three signalized intersections along the Billy Wolff-Antelope bikeway.

5. In order to encourage widespread use of bicycles for transportation purposes, a brochure was printed. Included in the brochure is a map showing the degree of difficulty in bicycling on all city streets and a summary of traffic laws and safety tips for bicyclists.

A user survey was conducted to determine the trip purpose and previous mode of travel. A total of 62 bicyclists were interviewed during the hours of 4:00 p.m. to 6:00 p.m. and 54 bicyclists were interviewed during the hours of 6:00 p.m. to 8:00 p.m. The predominant usage between 4:00 and 6:00 p.m. (48 percent) was commuters while the 6:00 p.m. to 8:00 p.m. sample showed primarily recreational usage (61 percent). A surprising number of bicycle commuters (41 percent) indicated that they would travel by automobile if the bikeway were not available to them compared with 33 percent who would continue to bicycle on an alternate route.

Bicycle counts were taken on the Billy Wolff-Antelope Bikeway at "A" Street to monitor the level of bicycle traffic before and after construction of the undercrossing improvement. The survey revealed that 250 bicyclists crossed "A" Street on an average weekday prior to the improvement while 870 crossed "A" Street following the improvement.

In general the bicycle system improvements were found to have a significant impact on improving safety and encouraging bicycle transportation to the central business district. The success of this bikeway has resulted in planning currently underway for another major commuter bikeway which will be northeast of the city with an approximate length of 3 miles.

Portland, Oregon

In 1983, the city of Portland, in cooperation with the Metropolitan Service District (the regional planning agency) and numerous local employers and businesses, established the "Bike There" program. Focused on bicycling for transportation purposes rather than recreational riding, the "Bike There" program had two objectives: 1) To improve the safety of the growing number of bicyclists in the Portland area, and 2) to increase the number of people who commute by bicycle throughout the region. The program is focused on bicycling for transportation purposes rather than recreational purposes. (Bicycling for transportation is distinguished from recreational riding by the fact that transportation riders have a particular destination, such as a place of work, school, or store).

The "Bike There" program contained four elements:

1. Production and promotion of a regional bicycle map showing the safest and most desirable bicycling routes throughout the metropolitan area.

2. An employer program to reach bicycle commuters and people interested in commuting by bike at their most logical meeting place, the worksite.

3. Coodination of two public events to generate interest in and share information about bicycling

4. A public information effort to support these activities.

In order to develop a program around these elements, a random telephone survey was conducted of adults 18 years of age and older. The survey questions addressed bicycling use, practices, and safety. The responses indicated that while fitness and other factors motivate people to ride bikes, concern about safety in traffic is the major deterrent to bicycling. To be effective in encouraging the use of bicycles for transportation, the program addressed both the positive and negative motivating factors.

Based on the information obtained from the survey, each of the four program elements were set up in the following manner.

1. The Regional Bicycle Map: The Regional Bicycle Map was designed to encourage bicyclists to make the best use of the existing transportation system. The map showed many of the safest and most desirable bicycling routes in the region. It was important for the map to portray a connected network of bicycle routes. This would allow bicyclists using the map to plan trips between destinations. The map also color-codes the routes according to the degree of bicycling difficulty and the character of traffic on the route. In addition, the map differentiates hills and shows difficult intersections. And finally, the map presented safe riding tips and diagrams explaining how to negotiate certain bridges (many contained roadway grates that preclude travel by bike).

Ten thousand copies of the map were produced on weatherproof stock. They were distributed and sold at book shops, bike stores, and other outlets in the Portland area.

2. The Employer Program: The employer program is modeled after successful rideshare programs and represents the most extensive effort to date in a large metropolitan area to reach bicyclists and potential bicyclists at the workplace.

The employer program, with a one and a half person staff, distributed bicycling information to all 2,600 businesses in Portland with 25 or more employees. More than 100 businesses participated actively in the program. Active participation ranged from using "Bike There" materials, such as posters and paycheck stuffers, to sponsoring week-long promotions. The activities used by the employer program include:

- Workshops to provide instruction and assistance related to commuting. The workshop topics included bicycle commuting, bicycle tune-ups, and fitness.
- General promotions at locations serving groups of employees, e.g., Portland State University, parks, and retail outlets.
- Paycheck stuffer brochures designed to present handy information on bicycle commuting, bicycle safety, and traffic safety along bike routes.
- Posters, flyers, and a regional bike map were all distributed as part of employer activities.

Employer participation was greater than expected with over 90 companies participating during the first summer. A total of 67 workshops or events were held during the summer along with distribution of over 47,000 paycheck stuffers and 350 custom route maps. Because of the strong employer program, approximately 20,000 employees were reached.

3. Events: Two public events were held as part of the "Bike There" Program. One was a Bike-to-Work Day, held in mid-May, which served to kick off the summer program. The second event, called Summer Cycle, was a family-oriented bicycle ride and fair scheduled in mid-August as a climax for the "Bike There" program.

The Bike-to-Work Day activities included:

- Free continental breakfast and guided rides from participating 7-Eleven stores throughout the region. Anyone riding to work that morning could sign up for prizes that included free bicycles, bike gear, radios, and sporting apparel.
- At noon in a downtown park, a Clean Air Fair was held with a bicycle safety theme. Door prizes and guest speakers were part of the Fair.
- An evening of bicycle films was held.
- Bike safety checks and information were also offered.

Public response to Bike-to-Work Day was considerable. Employers reported increases of 3 to 10 percent in the typical number of bike commuters. Front page newspaper coverage and editorials were positive and indicated a measure of success for the Day.

The Summer Cycle featured early morning bike rides. A registration fee was charged and proceeds benefited the Muscular Dystrophy Association. The Summer Cycle received major support from the Southland Corporation (7-Eleven) and other private businesses in the form of prizes, refreshments, registration materials, and volunteers. The emphasis of the activity was bicycle safety where recreational riders could learn about and practice safe riding skills. Approximately 850 riders took part in the Summer Cycle, a large turnout for the first year of an event like this.

4. Public Education: Some of the materials developed to support the employer program and the two events were incorporated into an education effort aimed at the general public. The purpose of this effort was to communicate basic safety principles and encourage people to use bikes, especially to work. The public education materials included:

- Calendars of bicycling events from May through September, listing bike trips, races, classes on safety, maintenance, and theft prevention.
- Public service announcements on radio and T.V.
- Bus exterior billboards stressing bicycle safety were placed on 300 buses.

The impact of the Bike There program was measured by the number of people the program reached, changes in the number of people who bicycle for transportation purposes, and the degree of public support for the program. Based on a followup survey, the Bike There program reached over 300,000 area residents with bicycling information. They were reached through radio and television announcements, news articles and advertisements, the Bike-to-Work Day, Summer Cycle, bus advertisements, and the bicycle maps.

The followup survey results demonstrated a small increase, since the beginning of the program, in the number of metro area residents who bicycle for transportation. During the month prior to the "before" survey in 1982, 3.6 percent of the respondents had biked to work at least once. This figure rose to 4.4 percent at the conclusion of the Bike There program in 1983. There was also a corresponding rise in each category of bike commuting frequency within the same month (i.e., people biking one time, two times, three times, etc., to work over the month long period). In addition, the number of persons who had tried bicycling to work at least once at any time grew significantly from the first survey to the second. Other notable increases in bicycling activity were shown in school trips (increased from 0.9 percent to 2.0 percent) and in shopping/personal business trips (increased from 7.9 percent to 13.2 percent).

The survey showed strong support for the program, Eighty-six percent of those surveyed supported the Bike There program and its continuation. Of the employers who had used the materials and services, 95 percent reported they were useful and expressed interest in continuing to encourage their employees to bike to work. Several employers did not see ***a*** substantial increase in the number of employees who biked to work. Strong sales for the bike maps also indicated community support for the program.

In conclusion, the Bike There program did achieve its objectives. Bicycling safety and encouragement information was communicated to several hundred thousand residents. Bicycling for transportation purposes rose slightly and the program received strong community support. The program also succeeded in getting over 100 businesses actively involved in promoting bicycling. Several major corporate sponsors have committed to continuing the program.

Because of the program several new bicycle facilities (paths, lockers, etc.) are being developed. Development of these facilities is being worked into the transportation planning process in Portland. Bicycle route and parking standards have also been developed by the communities in the region.

It is evident that the Bike There program has raised public awareness that the bicycle can be a real transportation option. The combined approach between the public and private sectors had the most affect on increasing the extent of transportation by bicycle.

Transportation for Special Events (1984 Summer Olympics, Los Angeles, California)

Providing for the safe and efficient movement of persons to and from major special events has long been a concern for transportation professionals. The experience of the State and local transportation professionals in the Los Angeles area in designing a traffic management program for the 1984 Summer Olympics should provide some valuable insights on addressing the problems created by special event traffic. In fact, much of what was learned in the Los Angles experience can be transferred toward establishing coordinated and responsive traffic management programs for maximizing the use of the existing transportation system.

In establishing a traffic management program for the Summer Olympics, the transportation professionals in the Los Angeles area were obviously undertaking a truly challenging effort. For example, an estimate of the parking required for spectators in the Coliseum area revealed the need for an additional 17,000 spaces. Also, up to 127,000 persons per day were predicted to be mixing with weekday commuter traffic in the vicinity of the Coliseum area. Further, one of the main arterial streets in the Coliseum area was closed to provide security for the Olympic Village. Numerous other examples could be cited to illustrate the monumental task facing the transportation professionals in the Los Angeles area.

In September of 1983, a transportation plan for the Olympics was established consisting of the following three major elements:

- Traffic management
- Olympic bus system
- Public information program

Traffic Management

The principle objective of the traffic management program was to maximize the traffic carrying capacity of the street system with low cost traffic engineering measures. No funds were available for major capital improvements such as street widening or parking structures.

In developing the program, the basic approach was to separate the traffic demand into the available modes of transportation. Each mode was evaluated and assigned to independent routes, with different traffic control measures being applied for each mode. The modes evaluated were auto, existing transit buses, special Olympic buses, charter buses, athlete buses, press buses, taxicabs, and limousines. Some of the traffic management measures implemented were the following:

- ***Operations Response Teams.*** These teams included traffic engineers, field personnel, and helicopter surveillance linked by radio communication and were located at key spots throughout the city of Los Angeles. This group was responsible for identifying and correcting several traffic problems.
- ***Automated surveillance and control.*** Using a recently installed computer signal control system for 120 intersections in the Coliseum area, the signal timing was adjusted from a central control center on request from the operations response teams. This measure enabled the establishment of special timing plans to reduce the congestion caused by the large influx of spectators to the Coliseum area. The action was supplemented by the assignment of traffic control officers to several critical intersections to separate heavy pedestrian movements from heavy vehicle movements.
- One-way ***streets.*** Two major arterials were converted to one-way operation to increase traffic capacity as well as allowing for the installation of bus priority lanes for the shuttle bus service.
- ***Bus priority streets.*** Several sections of major arterials were converted into bus priority streets. Turn restrictions were imposed along these routes and several freeway ramps to these streets were restricted to buses, allowing for the efficient movement of buses from the freeways to the Coliseum area.
- ***Parking restrictions.*** Extensive parking restrictions were applied on the arterial streets, with a special towing program and expanded enforcement patrols established to insure compliance.
- ***Route diversion signs.*** A route diversion plan was established to limit the traffic entering several critical intersections. Special, nonstandard guide signs were erected on both the freeway and arterial systems to delineate the alternate routes.
- ***Traffic coordination center.*** The center was established to coordinate the operational activities of all the transportation agencies and provide a communications link with the field teams, the

helicopter traffic spotters, and the management of the participating transportation agencies. In addition to the coordination center, the incident management program and its Traffic Operations Center established by the State was effectively used in the overall traffic surveillance system. The incident management program is staffed by the highway patrol and State traffic and maintenance experts. The Traffic Operations Center uses map displays, closed circuit cameras, helicopter and ground observation reports, and computerized traffic count data to analyze and react to major incidents. The existence of the program and the Traffic Operations Center proved to be a very valuable resource in managing the traffic during the Olympics.

Olympic Bus Program

The second element of the transportation plan was an Olympic bus system. An analysis revealed that about a 65 percent bus mode split was needed in the Coliseum area to handle the additional trips. The regional transit agency established a system to accommodate a 40 percent mode split, with the remainder to be handled by charter buses. An additional 500 buses were added to the regular public bus service. Three types of services were provided-shuttle, park-and-ride, and express-from the major activity centers in the region to and between the various event locations.

Preliminary statistics indicate that 1, 175,000 boardings occurred on the 24 lines making up the special bus network. In establishing the bus program 3,470,000 boardings were projected. Despite not meeting the 65 percent bus mode split, the number of persons carried on the special bus system was substantial and made a significant contribution toward meeting the additional traffic demand generated by the Olympics.

Public Information Program

The third and perhaps most vital element of the transportation plan was the public information program. The main objective of this program was to provide the public with information on expected traffic conditions so they could make informed decisions on how to get to the various events or how they could modify their commuting routes.

This program consisted of special packages to employers identifying congestion patterns at the various Olympic event centers, suggested altered work schedules and alternate routes, discussions with trucking associations and major shippers to encourage the shifting of routes or time of deliveries, and twice daily media briefings during the Olympics by representatives of the State and local transportation agencies. The public information program was in large part responsible for commuters staggering their work hours, getting residents normally accustomed to driving to a sporting event to use the bus, and significantly reducing the freeway truck travel during the peak periods.

Effectiveness of Transportation Program

The effectiveness of the transportation management program established for the 1984 Summer Olympics can be gleaned from looking at a few general traffic statistics. First, a few days prior to the Olympics, the freeway system was operating congestion free, with total daily traffic (ADT) volumes down about 2-3 percent. Peak hour volumes were about 7 percent lower than average, and the a.m. peak hour was beginning 30-45 minutes earlier.

During the first week of the Olympics, most roadway sections remained uncongested. The ADT volumes increased slightly throughout the week and were slightly above normal levels by the end of the week. Over the remaining period of the Olympics, the ADT volumes ranged from l-5 percent above normal levels. Most facilities operated uncongested, with the exception of a few incidents where heavy congestion developed in and around major event locations (Rose Bowl, Westwood area).

The Olympics traffic management experience illustrated that coordinated programs among the transportation professionals, the business community, and the commuter can contribute significantly to effectively handling the increased traffic created by special events. Much of what was accomplished during this major event, and in particular the interagency coordination and communication that was established, will provide a solid framework for addressing the urban mobility problems in the Los Angeles region.

Curbside Priority Bus Lanes (New York City, New York)

The use of curbside priority bus lanes in major activity centers is a well established transportation system management measure for improving bus reliability and user travel times. A problem that frequently occurs in the operation of these lanes, however, is the number of violations by motorists and truckers that result in the lane being blocked or being used as a through lane. As a project under the one-time TSM National Discretionary Grant Program, the New York City Department of Transportation (DOT) investigated ways to overcome this problem in order to achieve the maximum benefits of curbside priority bus lanes.

Since 1969, curbside bus lanes have been used as a transportation management strategy throughout the Manhattan CBD. These lanes vary in length and hours of operation but all share the common attributes of being curbside, with-flow lanes designated for bus traffic and right turning vehicles. Because of chronic violations and illegally parked vehicles, buses using these lanes achieved slower speeds (as low as 3.7 mph) than originally intended. Enforcement efforts were sporadic and public perception nearly nonexistent.

In order to address this problem, the Surface Transit Enforcement Program (S.T.E.P.) was established. Ten right-curb, concurrent flow bus lanes (a total of 11 miles) were designated under this program, with two of these 10 bus lanes being entirely new. A three-part approach consisting of engineering treatments, public education programs, and enforcement strategies was implemented.

Engineering Treatments

Several treatments were evaluated, including the physical separation of the bus lanes from mixed traffic lanes and channelization of the bus lanes using zebra striping. Because of problems in implying the use of 24-hour operation with such treatments, it was decided to use a unique signing and marking system.

To delineate the bus lane from the mixed traffic lanes, an 8-inch solid white barrier line in thermoplastic was used. The 20-foot long diamond pavement marking recognized by the Manual on Uniform Traffic Control Devices as the standard symbol for special use lanes was installed mid-block, on every block on each priority bus lane. In addition, the word message "BUS" was used as a reinforcement technique in identifying the lane as being reserved for these vehicles. This message was placed at the beginning and end of each block.

The final element of the markings design was the red zone concept. A solid red line along the curb was used to communicate to motorists that the bus lanes are for buses only. To make this line more visible against the black asphalt surface, an 5-inch white thermoplastic line was laid down first, with the 4-inch red thermoplastic line placed directly on top of it.

To further communicate the importance of the red zone bus lanes, a red zone sign was developed. These signs have a red background with white letters identifying the bus lanes as red zones. The signs also indicated that violation of the red zone bus lane would result in a minimum penalty of $100 (tow and fine). Two other non-regulatory signs were developed. The two signs state the following:

"No Parking, No Standing, No Stopping, No Ridding!" and "Don't Even Think of Parking Here." These signs were placed every four blocks along the designated red zone bus lanes.

Public Education Program

The public education program was a joint effort between the city DOT and the transit agency. As part of this program, a pamphlet was developed that highlights the major elements and goals of the program. The pamphlets were designed to be eye-catching and concise and were distributed to various community groups, public and private agencies, and special interest groups.

Large cardboard posters were produced with the slogan: "It's this bus or fifty cars, Keep New York City moving, Stay Out of the Red." These posters were placed on lampposts, poles, in storefronts, banks, and office buildings 2 to 3 weeks prior to the implementation of each red zone lane.

Short television commercials noting the positive aspects of the red zone bus lanes were shown over a several week period. The commercials were broadcast during a.m. and p.m. prime times (7 a.m.-9 a.m., 6 p.m.-7 p.m.) and during the 10 p.m. and 11 p.m. newscasts. Further media coverage was provided through an on-site event during the opening of one of the bus lanes.

Finally, city DOT officials met with several citizen groups, business officials, and public and private agencies to explain the red zone program. These meetings were held prior to the opening of the first red zone bus lane.

Enforcement Strategies

In order to ensure adequate enforcement along all the red zone bus corridors, several types of enforcement strategies were implemented. These strategies included the use of intersection control agents, parking enforcement agents, increased tow surveillance, "scare/ghost" tow trucks, non-uniformed enforcement agents, and rooftop observations.

During the initial implementation periods of the red zones, 15 full-time traffic control agents supplemented by 75 agents from the city DOT were patrolling the various red zone locations. A van, manned by the project manager and enforcement supervisors, was used to coordinate the enforcement efforts of the control agents. After a very intensive enforcement period (2-4 weeks following implementation), the enforcement efforts were scaled down. In addition to the street patrols, a rooftop observation post was established during the initial implementation period to assist in identifying problem locations.

Several key intersections were monitored at all times during the early implementation period by intersection control agents. As more red zone lanes were implemented, it became impossible to provide coverage at every intersection of every red zone bus lane. Instead, these agents were assigned to those intersections that were observed to need enforcement efforts.

Also, "ghost/scare" tow trucks were used very successfully as an enforcement strategy. A "ghost" tow truck would generally not tow any vehicles but would patrol the red zone lanes to frighten motorists sitting in a parked vehicle along the curbside. This approach was particularly effective along the red zone lanes where commercial storefronts attracted vehicles to temporarily stop. The use of the "ghost tow" approach also allowed for a broader coverage of tow surveillance, particularly when other tow trucks were removing illegally parked vehicles to the tow pound.

The enforcement strategies used to keep the red zone lanes free of violators proved to be very effective. Prior to the S.T.E.P. program, the curbsides were free of vehicles less than 50 percent of the time. After 1 year of operation, the lanes were free of vehicles nearly 80 percent of the time, with some lanes as high as 95 percent of the time. The intensive efforts of enforcement during the early implementation period was a major factor contributing to the success of the enforcement program.

Evaluation

Before the S.T.E.P. program was implemented, the average bus speeds for all the existing priority bus lanes was 4.7 mph. Following 1 year of operation for all 11 red zone bus lanes, the average bus speed increased to 5.6 mph, representing an improvement of nearly 20 percent. The improvement in bus speeds ranged from 4.3 percent to 55 percent, with one lane showing no change in bus speeds. The bus lane with no increase in travel speeds was due to the large amount of new office construction that occurred at several sites adjacent to the lane, creating delays or blockages.

Peak hour bus speeds exhibited an even greater improvement, ranging from increases of 2 percent to 88 percent. The average increase in peak hour bus speeds was nearly 30 percent.

The average speed of general traffic (excluding buses) on the streets with a priority bus lane was 7.9 mph prior to the implementation of the S.T.E.P. program. After 1 year of program operation, the average speed for the general traffic increased to 9 mph, resulting in an almost 15 percent increase in speeds. The largest increase of any single roadway was nearly 90 percent. The peak hour general traffic also showed a significant improvement, increasing 50 percent.

The S.T.E.P. program illustrates a very successful attempt at improving the travel time savings for bus users, as well as increasing the public awareness of priority bus lanes in Manhattan. The strong and consistent enforcement element, coupled with the public involvement and awareness programs, contributed to this successful effort.

Commuter Ridesharing Behavior in Urban Areas (Atlanta, Cincinnati, Houston, Portland and Seattle)

This analysis of commuter ridesharing behavior in five cities focuses on the characteristics of ridesharers, the workings of Carpool and vanpool arrangements, the relationship between employers and ridesharing, and the impact of ridesharing programs in urban areas. The analysis is based on the results of a workplace survey administered to a total of over 800 employers and more than 11,000 employees in Atlanta, Cincinnati, Houston, Portland (Oregon), and Seattle. The employee and employer workplace surveys were developed by the U.S. Department of Transportation's Transportation Systems Center as part of the evaluation of the National Ridesharing Demonstration Program (NRDP). The results and findings presented in this section should be particularly useful in designing cost-effective areawide and employer specific ridesharing programs.

Employee Ridesharing

The employee survey asked respondents to identify their primary current (1982) means of transportation to work, and also the mode they used 2 years prior to the survey. The results indicated no significant change in the mode split for commuters from 1980 to 1982 as shown in Table 1. The average level of employee ridesharing for the five sites in 1980 was similar to the national average for ridesharing to work that year (19.7 percent). Of the five cities, Houston had the highest ridesharing mode split, 25.9 percent.

Table 1

1980 and 1982 Commute Mode Split

(Five City Average Percent)

	1980	*1982*
Ridesharing	21	20
Single-occupant auto	64	66
Public transit*	12	12
Other**	3	2

* Includes subscription bus
** Includes walk, cycle, taxi, "other" responses

Sociodemographic, motivational, and employment characteristics of ridesharers were examined by cross-tabulating responses to the employee workplace survey at five sites. Some of the results confirm previous findings, while others are at variance with earlier ridesharing research.

Results of the survey analysis confirm other studies which show a relationship between sex and propensity to rideshare. At all workplace survey sites, the ridesharing mode split was higher for women workers than for men. On the other hand, survey results showed no consistent relationship between age and propensity to rideshare. This finding conflicts with that of other researchers who have suggested that ridesharers are disproportionately represented within certain age groups.

Evidence associating **income** with ridesharing was less clear-cut. At all sites except Portland, employees with (1982) household incomes below $15,000 were more likely to rideshare than employees in most other income groups. In Portland, workers in the lowest income bracket were least likely to Carpool. It was hypothesized that auto ownership may be a better variable than income to explain mode choice. In fact, results of the workplace survey showed a correlation between ridesharing and **car ownership** patterns. At all sites except Houston, ridesharing employees were more likely than the average employee to have more than zero cars in their household. At the same time, ridesharing employees were less likely than the average employee to have more than .75 automobiles per employed household member. This is logical, for several reasons. First, most ridesharers drive some of the time, which necessitates at least partial access to a car. Second, a large proportion of Carpools involve two family members commuting together, which would require household access to a car. Finally, many employees who rideshare do so in order to leave a car at home occasionally for the use of other household members, which also implies car ownership.

Studies have also suggested that cost savings is a more likely **motivation** for ridesharers than for other commuters. Responses to the workplace survey question asking riders to give the reasons for their choice of mode confirmed this finding. Ridesharers mentioned cost as the most important consideration more often than all commuters did-25 percent of the time versus 15 percent of the time. However, ridesharers were also motivated by considerations similar to those of other commuters (i.e., convenience, travel time, schedule requirements, and unavailability of transit).

Among the **job-related factors** shown by the workplace survey to be associated with employee propensity to rideshare were company/agency size, distance to work, full versus part-time work, and work schedule. Workplace survey results showed company/agency size to be highly correlated with employee ridesharing behavior. For all sites, the ridesharing mode split was higher at companies/agencies with more than 100 employees than it was at smaller ones. This finding is consistent with earlier and recent research. The positive association between firm size and level of ridesharing can at least partly be explained by company/agency size alone. The larger the company/agency, the greater the number and density of potential poolers at one location. Thus, a worker's chances of being exposed to ridesharing requests and of finding a suitable co-rider are greater.

Mean **distance from work** among the major demonstration sites was 11.7 miles, ranging from under 10 miles to over 14 miles. Ridesharing was a more likely mode choice as distance from work increased, beyond a threshold distance which varied from site to site. For Houston and Portland, this threshold was 10 miles, while for Atlanta, Cincinnati, and Seattle, it was 15 miles. Workers living beyond the threshold distance were more likely to rideshare than the average workers. The higher cost of individual auto trips over longer distances and the decreased availability of public transit presumably make ridesharing comparatively more attractive for longer journeys to work.

Full time workers at all sites were more likely than part-timers to rideshare, a finding consistent with the positive association also found between fixed work hours and propensity to rideshare. At all sites, there were no significant differences in ridesharing mode split for employees on **fixed-hour** schedules versus those who set their own schedules which are thereafter fixed. Compared with those fixed hours, however, employees with **flexible-start schedules** presented a mixed picture. (Flexible-start schedules were understood to mean those requiring a fixed number of work hours per day while allowing the worker to choose a start time, usually from a range of hours, or what is commonly termed "flextime.") On the basis of this finding the introduction of flextime could not be associated with increased or decreased ridesharing.

Carpool Arrangements

Analysis of survey questions about carpool size **and composition** at most sites showed more than half of all carpoolers to be in two-person Carpools. A high proportion of the members of two-person Carpools lived in the same household, which is not surprising, because of the ease of making and changing arrangements and the absence of circuity at the home end. Between 47 and 61 percent of those ridesharing in two person carpools share the ride with a family member. By contrast, fewer than one-third of the members of three- or four-person carpools shared the ride with one or more family members.

The proportion of carpoolers whose members all worked for the same employer was found to increase with carpool size at most sites. While women were more likely than men to Carpool, as already discussed, men were more likely to drive in a Carpool than women. On an average, 37 percent of men and 21 percent of women employees always served as the driver of their carpool and 1 percent of men and 59 percent of women sometimes served as the driver.

Although the workplace survey did not distinguish between kinds of Carpools on the basis of size, Carpools with seven or more members were termed "vanpools" and described separately, because results indicated that they were distinctly different from smaller Carpools. For example, no household members commuted together in more than three-fourths of the Vanpools at most sites, but half or more of the members of Vanpools with 10 or more persons worked for the same employer. Overall, a low proportion of vanpools had members who all worked at the same location, but for different employers. This number was higher for the larger Vanpools than for the smaller ones.

The overwhelming majority of ridesharing arrangements at most sites resulted from informal contact at work or from household members' deciding to commute together. However, the method of formation varied by carpool size, with the largest and smallest Carpools demonstrating very different formation characteristics. Most two-person Carpools were formed by household members, while most Carpools with 10 or more persons were formed at work. Formal mechanisms such as company newsletters and matching lists, were used more widely by members of the largest carpools than by those in the smallest ones.

These results have important implications for rideshare marketing. If over 60 percent of carpoolers (five-site average) are in two-person Carpools and more than 50 percent of two persons carpooling (five-site average) is done by family members, it is likely that a substantial portion of carpooling arrangements will continue to be made at home. In addition, a large percentage of persons who might be disposed to rideshare are family members who already rideshare in two-person Carpools, which limits the potential market for ridesharing development through employers.

At the same time, because carpool size increases with company/agency size, and larger Carpools are more likely to be formed by fellow workers, a much higher proportion of carpoolers at large companies/agencies than small ones can be expected to make use of institutional assistance programs in making ridesharing arrangements. It is also possible that multi-employer work sites may function like large companies/agencies; that is, they may provide opportunities for ridesharing development, but this hypothesis could not be tested with these data.

Evidence on the **dynamics** of ridesharing arrangements, the relative duration and stability of ridesharing and other modal commuting patterns were remarkably similar across the five sites. The responses showed a considerable amount of movement into and out of carpools and other modes over time, as shown in Figure 1. For example, of those who were driving alone to work 2 years prior to the survey (1980), 85 percent were still driving alone at the time of the survey. By contrast, the percentage of employees carpooling 2 years earlier who were still carpooling in 1982 was much lower, or 58 percent. The retention rate of transit riders was similar to that of carpoolers: 58 percent of those who were taking transit 2 years earlier were transit riders at the time of the survey. It is taken for granted that some commuters in all three groups may have switched modes more than once during the 2-year period, but that does not affect the overall conclusions.

Over 70 percent of new carpoolers (i.e., those carpooling in 1982 who were not carpooling in 1980) formerly drove alone, and nearly 20 percent formerly used transit. The remaining new carpoolers included those who formerly walked, worked at home, or took other modes. The mode-switching process works in several directions. About 65 percent of those new to the drive-alone mode were ridesharing 2 years ago, while 24 percent were former transit users.

It can be seen that, because the drive-alone mode is so large (approximately 60 percent of all commuters at any one site), even a small increase in the percentage of newcomers to this mode can represent a substantial drain on ridesharing and transit mode shares. In light of this finding, rideshare marketing should perhaps focus on reinforcing current Carpools, in order to stem the flow of commuters into single-occupancy autos.

Characteristics of Surveyed Companies/Agencies

Most of the companies/agencies at each of the five sites were small enterprises. More than 80 percent of them had fewer than 20 employees, and over 95 percent of them had fewer than 100 employees. At the same time, larger companies/agencies accounted for more than one-third of the employees at each site. The distribution of firm types varied from one site to another, but retail, manufacturing, and business services were among the kinds of companies/agencies found most often at a majority of the sites. A substantial majority of employees at the five sites had fixed work hours. Variations to this schedule were diverse, and differed between sites.

Free (non-employer-provided) parking was available within a quarter mile of the work site at most companies/agencies. About three-quarters of all employers provided parking (usually free) for their employees. At sites where parking was not available, employers furnished employee parking, with the exception of Seattle. At all sites except Houston, over 40 percent of the employers had been at their current location more than 10 years. At all sites, over one third of the employees had been at the same location between four and 10 years. Employers newly arrived in the past 4 years constituted less than one-fourth of all employers at every site except Houston.

Transportation Assistance

The proportion of employers offering transportation assistance of any sort to employees was examined, to determine whether there was a relationship between employee mode split and the amount and kind of assistance being offered. It was found that, on the average, more than half of the firms did not offer any transportation assistance to their employees. The proportion of firms offering assistance ranged from 50 percent in Seattle to 28 percent in Houston. Of those offering transportation assistance, fewer than one-third offered ridesharing incentives such as preferred parking and vanpool transportation. At every site, a large majority (i.e., 57 to 87 percent) of employers offering ridesharing assistance stated that the benefits of employer-sponsored ridesharing outweighed the cost. At the same time, for all sites except Houston, employers not providing ridesharing assistance were much less likely to view such assistance as beneficial.

Ridesharing assistance was correlated with firm size. At large firms, employees were more likely to rideshare, Carpools were apt to be larger, and employees were more likely to use employer assistance in forming carpools. Because the employers who offered rideshare assistance were large, the aid they offered could reach a large number of employees. It follows that such companies/agencies will be more efficient settings for reaching the employee ridesharing market, in terms of numbers and concentration of workers.

The employee ridesharing mode split at those companies/agencies offering "active" ridesharing assistance (defined as help, such as matching services, in joining or forming Carpools) was higher than at other companies, as one might anticipate. While an active ridesharing assistance program may well induce some employees to rideshare, it may instead be the result of employee demands. Because large employers offered assistance more often than smaller ones, the ridesharing mode split was examined for employees of companies/agencies in all size categories. The reason for this was to see whether size alone explained the higher rideshare mode split. It did not.

Area Ridesharing Programs

Area ridesharing programs were active at each of the five sites at the time of the workplace surveys. An important focus of the surveys was to examine the impacts of these programs on employee ridesharing. This impact was evaluated in two ways: (1) by comparing rideshare mode split at firms having "contact" with an area ridesharing program with the mode split at firms not having contact; and (2) by examining employees' perceptions of the impacts of the programs. Contact with the ridesharing program included both employer contact by the ridesharing program as well as successful attempts by companies/agencies to receive ridesharing information and/or aid from the ridesharing program. In other words, "contact" could work in either direction.

For those firms which were in contact with the local ridesharing program, the percentage of employees ridesharing was significantly higher at all sites than it was for those firms which were not in contact, as shown in Table 2. We cannot say for certain that contact increased ridesharing, since the programs may have tended to contact companies/agencies which already offered ridesharing assistance. While the survey results showed that assistance was much more likely to be found at contacted companies/agencies, there is no way to tell whether assistance or contact came first, based on the survey.

To see whether employer assistance explained the effect of program contact on ridesharing behavior, the population of employees was subdivided by whether the employer offered ridesharing assistance. For each subgroup, the ridesharing mode split at companies/agencies contacted was compared with the mode split at ones not contacted. For companies/agencies which offer ridesharing assistance, contact was associated with a significantly higher mode split at three sites-Atlanta, Houston, and Seattle. Little difference was seen in the ridesharing mode split of employees at contacted versus non- contacted employers who did not offer ridesharing assistance, except in Portland, where a higher rideshare mode split was associated with contacted companies/ agencies.

Table 2

EMPLOYEE RIDESHARE MODE SPLIT BY COMPANY/AGENCY CONTACT WITH RIDESHARING PROGRAM

(Five-Site Average Percent)

Companies/agencies with contact	26
Companies/agencies without contact	18
All companies/agencies	20

It was hypothesized that company/agency size, which was associated with more company/agency contact, might account for the higher ridesharing mode split at contacted companies/agencies. Further analysis showed this was generally not the case. Mode split was usually higher for contacted employers offering assistance, regardless of size. The results presented here, however, do not prove causal relationships between program contact and ridesharing. On the one hand, contact with the ridesharing program may enhance the effect of an employer's ongoing ridesharing efforts. On the other hand, area ridesharing programs may simply have targeted employers whose ongoing rideshare assistance programs were most successful.

To further evaluate the effect of area ridesharing programs, their relative usefulness to employees was examined. The vast majority of employees at all five sites indicated they received no assistance at all from the ridesharing program (86.6 percent). An additional group received aid (12.5 percent), but did not use it, for whatever reason. Only about 1 percent stated that they were helped to form or join a Carpool by the ridesharing program.

When the question was limited to current ridesharing employees, about 3 percent found the ridesharing program of direct help. Assistance to employees was often channeled through employers, as many ridesharing programs consciously strove to transfer on site responsibility for such assistance to employee transportation coordinators. Such policies in turn could mean that employees perceived rideshare marketing efforts as coming from their employer, rather than from the area ridesharing programs which had initiated the assistance.

Conclusions

Results of the study hold a number of implications for the design and focus of rideshare programs. Most of the findings suggest that persons living relatively long distances from work are more likely candidates for ridesharing than other commuters, all else being equal. Both employer specific and areawide rideshare programs should continue to emphasize cost savings from ridesharing, because it is an important factor in a ridesharing commuter's decision. Other factors which should be emphasized are convenience and time savings, where applicable. At the same time, because more than 80 percent of all carpools are formed within households or by informal work contact, it should be recognized that the potential for developing new carpools by formal program mechanisms alone is limited.

Most employees at firms offering ridesharing assistance worked for large firms, where employees were both more likely to rideshare and to form larger Carpools. Thus, given an areawide rideshare program, it is reasonable to focus on large firms. Firms already offering ridesharing assistance should not be ignored, because contact with the rideshare program may enhance an employer's own efforts. Although ridesharing programs had contacted companies/agencies employing about half of the employees in a region, on average, fewer than 20 percent of all employees in a region had actually received program materials. Even at contacted companies/agencies, fewer than one-third of the employees received such materials, which suggests that rideshare programs might try more intensive follow-up efforts.

The impact of both areawide and employer specific ridesharing programs on commuter travel behavior cannot be conclusively determined from the data. It is important to remember, however, that such an impact is likely to affect a small percentage of the overall commuter market. On average, 2 or 3 percent of those carpooling at the time of the survey credited their local ridesharing program directly with helping them to rideshare.

About 8 percent of carpoolers stated that either their employer's matching program or newsletter was their primary reason for joining or forming a Carpool. Some of this employer ridesharing assistance could have been the result of area ridesharing program efforts channeled through employers.

Other indirect effects of ridesharing programs on mode split may be considerable, but could not be measured. The actual number of persons assisted could vary substantially, of course, depending on the size of the local commuter market. It is clear that a rideshare marketing program should expect to be an ongoing effort, since nearly half of the ridesharing commuters surveyed were found to revert to other modes over a 2-year time period.

Parking Management and Shuttle Service (Orlando, Florida)

The city of Orlando implemented a downtown park-and-ride shuttle transit system as part of a comprehensive transportation system management program. The major objectives of this program were to increase automobile occupancy, increase transit ridership, reduce the number of automobiles and demand for parking facilities, reduce energy consumption, and improve air quality and traffic flow in the downtown area of Orlando.

The city of Orlando lies at the heart of one of the fastest growing metropolitan areas in the United States. The explosive growth in population and employment generated by the opening of Disney World and other tourist attractions and the regional migration to the Sunbelt has resulted in a strong demand for new housing units, office buildings, tourist facilities, shopping centers, and industrial buildings. In addition, this rapid growth has created the need for many transportation improvements.

In 1982, the city of Orlando implemented a comprehensive transportation management program aimed at the management and improvement of peak hour conditions that were primarily caused by basic home to work trips. The strategies included traffic signalization improvements; transit service improvement; ridesharing; parking supply management programs; and alternative work schedules. The primary target area for this program was the city of Orlando CBD and the arterial streets leading to the CBD.

The implementation of this comprehensive program required input from a number of agencies, both public and private. The city of Orlando was the lead agency with participation from the Metropolitan Planning Organization, the East Central Florida Regional Planning Council, the Florida Department of Transportation, the Orange-Seminole-Osceola Transportation Authority, the Parking Advisory Commission, the Downtown Development Board and local businessmen.

One of the more innovative aspects of this transportation management program was the downtown park-and-ride shuttle transit system operation. The purpose of this shuttle was to encourage long-term peripheral and fringe parking adjacent to the CBD. Expected benefits included reduced auto usage in the CBD and a more pedestrian-oriented CBD.

Several alternative routes were proposed for incorporation into the downtown shuttle system. One route was designed to connect the public-owned parking facilities adjacent to the CBD with the local businesses and State and local government offices in the CBD. The route operated during morning and evening peak hours. An additional route was proposed to operate during the noon hour only and serve major downtown generators such as City Wall, County Courthouse, State and Federal offices, major office towers, and the many lunch time eating establishments in the downtown area.

Various pricing schemes were proposed for the shuttle system such as free-fare zones, dime-a-ride, and monthly passes. Commuters were encouraged to use the system by the establishment of parking related transit incentives such as preferential parking for carpools and Vanpools. Parking price incentives/disincentives were also established to encourage commuters to rideshare to the parking facilities adjacent to the CBD and then transfer to the shuttle transit system for their trip into the CBD.

In February 1982, the downtown park-and-ride shuttle operation was implemented in the CBD. The system, known as the "Meter Eater," initially used two trolley buses that were leased at a total cost of $9,000 per month. It was expected that $6,000 per month would be recovered from advertising space inside and outside the two vehicles and $3,000 from the rider fares.

The city of Orlando adopted a fare structure of 25 cents per ride during morning and afternoon rush hours (7:00-9:30 a.m. and 3:30-6:30 p.m.). Anyone purchasing a monthly parking pass for the parking facilities adjacent to the CBD at a cost of $17-$30 per month also received a monthly Meter Eater pass. To encourage the use of ridesharing to these parking lots, discounts were provided in the per person monthly cost of the combined parking and Meter Eater passes for vehicles of two or more.

The city originally intended to use new transit buses on the shuttle bus system, but the delivery of the buses was delayed until August 1982. The purchase of trolley buses using Urban Mass Transportation Administration (UMTA) Section 5 funds was also considered, but the time involved in securing the grant would have delayed the timely start-up of the system.

Major employers in the CBD were encouraged to participate in the Meter Eater program. Sun Bank, for example, set up an employee incentive plan. Under this plan, the employer pays $10 of the monthly $17 parking and trolley bus fees for employees driving to work alone and the full $11 per employee for carpoolers.

The initial ridership on the Meter Eater trolley buses was 300 persons per week. Through extensive promotion of the shuttle service, ridership increased to 1,200 persons per week after 2 months of operation.

In June 1982, ridership was up to 2,000 persons per week. Many new riders were being added due to employer subsidy programs and the promotion program. New free midday service was initiated in the fall of 1982 to increase revenue ridership during the morning and evening commuter service between the parking lots and the CBD. While ridership increased to 3,300 persons per week by the fall of 1983, the major increase was nonrevenue midday riders. The advertising on the vehicles was also not generating the expected revenue. While outside advertising was popular with CBD merchants, especially restaurants, inside the vehicle advertising was hard to sell.

In October 1983, the Meter Eater trolley buses became part of the regional transit system. Due to the popularity of the trolley buses by the riders and the local merchants, the transit agency decided to keep trolley buses on the routes rather than switch to transit buses. An UMTA Section 5 grant was applied for to purchase trolley buses to replace the leased ones. In a show of support for the Meter Eater system, a major employer group, the Downtown Development Board, contributed $100,000 toward the local match for the purchase of vehicles.

In February 1984, ridership was up to 3,750 persons per week. A new Friday service during the midday was initiated to a series of senior citizen highrises. The route revision that extended the midday loop a few extra blocks generated between 60 and 70 riders who usually took the trolley bus to go shopping.

Results of a summer 1984 user survey indicated that 64 percent of those persons filling out the survey did not drive through the downtown in order to get to the parking lot. This is consistent with what was anticipated when the parking location was selected. Further, this general location will be used to construct the parking garage that will ultimately replace the current surface lots. Potential parking sites, on the south side of the CBD, are being investigated in an effort to “anchor” both sides of the downtown with transit-supported parking, as called for in the city of Orlando Growth Management Plan. In the meantime, however, it appears that a majority of the Meter Eater users are being diverted from the downtown area.

The Meter Eater system is currently operating as part of the Tri-County Transit (formerly known as the Orange-Seminole-Osceola Transportation Authority) with a revenue/cost ratio at around 40 percent. The operating expenses are approximately $25 per hour for each vehicle or $850 per day using four vehicles.

In order to encourage further use of the Meter Eater system, Tri-County Transit has created the Meter Eater Club. Persons purchasing the monthly Meter Eater pass are automatically members of the club. Club members can receive discounts at participating establishments in the downtown area by showing their monthly pass. The merchants see the club as a good way to encourage people to shop downtown at lunchtime rather than going to suburban shopping malls after work.

The trolley bus concept is also catching on in other cities around the country. The main objective of all these various trolley bus systems is to reduce the number of automobiles and the demand for parking in downtown areas in an attempt to improve downtown mobility. The various systems are designed to serve commuters, tourists, shoppers, and special events. The growing list of trolley bus systems includes such cities as Clearwater, Florida; Austin, Fort Worth, and San Antonio, Texas; Tulsa, Oklahoma; Birmingham, Alabama: Gatlinburg, Tennessee; Milwaukee, Wisconsin; Lexington, Kentucky; Kansas City, Missouri; Indianapolis, Indiana; and the five-city Tidewater region of Virginia.

Transportation Management Teams (Chicago, Illinois)

Based on experience, one of the essential ingredients to implementing effective transportation management projects is coordination among appropriate actor groups, e.g., traffic engineers, police, transit operator, utility companies, and private employers. This coordination becomes important when problems are identified and solutions affecting a variety of interest groups are to be implemented. The transportation management team enables such coordination to take place.

The Mayor’s Traffic Management Task Force is such a team in Chicago. It was established as a formal mechanism for the coordination of activities affecting transportation. This case study describes the development, purpose, and scope of the Task Force. It also illustrates how operational techniques (i.e., traffic signal improvements, bus lanes, and parking enforcement) are coordinated and incorporated into an overall transportation improvement program.

The Mayor’s Traffic Management Task Force began in the summer of 1982 focusing on traffic problems in the downtown. The Task Force was a recommendation of an earlier study on downtown traffic congestion sponsored by the Department of Public Works. Since 1982 the Task Force has broadened its scope to include traffic problems throughout the entire city.

The Task Force is composed of executives and professionals from the city and regional transportation agencies as well as interested members of private sector organizations. The agencies from the city include the Departments of Streets and Sanitation, Public Works, and Police. Also represented on the Task Force are the Chicago Transit Authority and the Chicago Area Transportation Study (CATS). Because of the importance attached to its work by the Mayor, the Task Force meetings were held on a weekly basis and chaired by the head of the Department of Public Works.

Providing a forum for coordination of city projects and programs is an essential function of the Task Force. Because such a forum existed, several significant accomplishments resulted in the city:

1. A temporary pedestrian crosswalk area was provided at a major sewer construction site.

2. Ticketing and towing of illegally parked vehicles in the Chicago Downtown increased by 100 percent.

3. The "Weekly Traffic Bulletin" was published to inform the public about changes in traffic regulations and current conditions.

4. The "Hotline" (dial S-T-R-E-E-T-S) was established giving information on regionwide peak period traffic problems, downtown traffic issues, and major events. The recorded message is changed three times daily.

5. One-way traffic on five major streets in the downtown area was established or continued.

Some of the Task Force projects, such as the one-way streets and the parking enforcement program, have had an impact on traffic flow in the central business district (CBD). Comparing traffic data from before and after the establishment of the Task Force recommendations, it was found that there was a 23 percent increase in traffic speed (6.5 to 8.1 miles per hour) in the CBD.

The Task Force is involved in nearly all construction projects throughout the city, by monitoring construction progress and assessing traffic impacts. The projects typically include sewer repairs, street resurfacing, and roadway reconstruction. The Task Force coordinates with the Alderman of the affected ward to devise a bus rerouting plan, institute temporary no-parking tow zones, establish a construction plan, and implement a public information campaign notifying area residents of the changes. Such coordination has led to smooth project implementation and more citizen and political support for work activities.

When several projects occur within a small defined area, such as the CBD, the Task Force inventories and identifies potential traffic congestion locations. Agencies responsible for construction projects which showed traffic congestion potential are contacted to assure coordination in project scheduling and encourage other measures necessary to mitigate the effects of construction. The early coordination activity is then followed up with the same weekly project monitoring and problem solving that are applied to other city projects.

The Task Force is involved with a variety of other projects within the city. Some of these projects include designating one-way streets, traffic speed revisions, construction detour planning and monitoring, and parking enforcement (including programs for scofflaws, towing, and ticketing). The Task Force also is actively involved in traffic management for major, one-time (or annual) special events. These include "The Taste of Chicago," "Chicagofest," "America's Marathon," and other special events. In addition, the Task Force does get involved with other special transportation issues, such as CBD goods delivery and revisions to the City Traffic Code. The Task Force reviews these issues and provides recommendations to the Mayor and Department heads.

One of the most significant projects for the Task Force, from a coordination and project management perspective, has been the Lake Shore Drive reconstruction and relocation. The project began in 1984 and will last for 3 years. During the construction, all southbound expressway traffic will be detoured onto an adjacent city street through the CBD. Northbound traffic remains on Lake Shore Drive using whichever half of the roadway is available at the time.

The Task Force was able to develop and implement a traffic plan that was designed to mitigate the adverse impacts of the Lake Shore Drive construction. Alternate routes were established for the Southbound traffic. All stopping, standing, and parking on these routes was prohibited. Two of the major alternate routes were made one-way southbound during the construction; however, northbound bus lanes were established on these arterials so that transit service was not disrupted. In addition, new signal equipment and coordinated timing plans were installed to maintain traffic flow along alternate routes. Traffic control officers were placed at critical intersections during the rush hour and goods deliveries were restricted to non-rush hour periods in an attempt to maintain traffic flow. Although some vehicle diversion occurred out of the corridor, traffic flow over the alternate routes was maintained.

In order to effectively implement this traffic management plan, the Task Force undertook the following series of actions:

1. Meetings were held with affected local political leaders (Aldermen) to discuss the proposed traffic plans and possible sources of complaints.

2. Meetings were held with transit agencies to develop route changes and other transit service improvements.

3. Meetings were held with affected residential and commercial building managers to solve site access problems caused by the construction. Similar meetings were also held with parking garage operators who might be impacted by the project.

4. Meetings were frequently held with all contractors, resident engineers, project engineers, police, and traffic personnel to ensure an understanding of the contract provisions regarding installation and maintenance of the detour signs, markings, and barriers. Also, these meetings were used to establish communication links so that any problems or breakdowns could be immediately addressed and resolved.

5. Meetings were held with traffic patrol servicemen, the police, and radio room personnel to make sure that everyone understood the extent of the detour plan and the need for good communication throughout this project.

6. An intense towing program was started along detour routes. This was preceded by a warning ticket program 1 week before the detour went into effect.

7. A comprehensive media/public information campaign was undertaken to alert motorists to the upcoming detours and encourage the use of alternate routes and services (e.g., transit).

8. A system of media contact/public information was established so that changes in the detour routes could be quickly announced to the public and questions by the media answered promptly.

9. The project is discussed regularly at the weekly meetings of the Task Force and bi-monthly at the regional planning meetings.

10. Traffic flow data are continuously collected for evaluation purposes and to monitor operations so that adjustments to the traffic management plan can be made as needed (e.g., retiming traffic signals).

The results of the Task Force efforts on the Lake Shore Drive construction project has led to greater public acceptance and support for the detour and traffic management plan. Relatively few traffic problems have occurred since the detours began. There was a 40 percent decrease in peak period traffic volumes through the detour after construction began; however, volumes have increased and are currently about 10 to 15 percent less than the pre-construction period. On a 24-hour basis, there have been no significant changes in ADT which run in the 80,000 to 90,000 vehicle range. Traffic increases have been observed on parallel routes, especially in the morning peak period.

Travel times through the detour area did not change during the morning peak period; however, there has been a 4-minute increase in travel time during the evening peak period. Traffic volume and travel speed data are continuously being collected as part of the monitoring and evaluation effort of the Task Force.

The Traffic Management Task Force has taken significant steps toward improving traffic conditions in Chicago, especially in the central areas. The Task Force has broken down the barriers to project coordination and has fostered effective cooperation among public and private organizations. The full support of the Mayor's Office for the work of the Task Force established the needed credibility and enabled the coordination and cooperation to take place. The key lesson to be learned from the Chicago Task Force experience is that coordination is an essential factor among both the public and private sectors if effective transprotation management projects are to be implemented. For Chicago, the Task Force provided an effective forum for managing, directing, and monitoring transportation improvements.

Transportation Management Associations-(Hacienda Business Park-Pleasanton, California)

Since early 1984, Hacienda Business Park has had one of the most effective transportation management programs for a suburban development. With 2,700 surveys recently returned, representing 87 percent of the employees working at Hacienda in June 1985, the Park showed that 31 percent of the employees do not drive alone to work. Further, 28 percent miss the morning commute peak between 7:30 a.m. and 8:30 a.m., and 51 percent miss the afternoon rush hour between 4:30 p.m. and 5:30 p.m.

Located in the city of Pleasanton about 32 miles southeast of San Francisco, the 860-acre business park is the largest in California. It is expected that 11.7 million square feet of light industry and office space will be built, generating 24,000 to 30,000 jobs. Current tenants include AT&T Communications, Sheraton Hotel, Hewlett-Packard, Viacom Cablevision, Fleming Companies, Security Pacific National Bank, and General Electric Credit. The Park developers and employers helped draft the model TSM Ordinance for the city of Pleasanton, and now are working to assure its successful implementation.

The Park's Transportation Manager represents Hacienda employers' interests at the local and regional levels. The Park regularly works in conjunction with the Bay Area Rapid Transit (BART), the Metropolitan Transportation Commission (the regional transportation planning agency), and RIDES (the Bay Area's ridesharing agency). The Transportation Manager also advised local cities as they formed the Livermore/Amador Valley Transit Authority.

The early success of the Park's program is considered to be due to several factors. These include institutionalizing the employer and Park transportation management program, the personal enthusiasm of the company-appointed transportation coordinators, the high employee density at some employer sites, and employers' desire to comply with the City TSM Ordinance.

The systems put in place by the Business Park provide the format for developing worksite transportation management programs and incorporating consistent, Park-wide incentives. The Covenants, Conditions and Restrictions governing the Business Park specify that all owners, leasees and other occupants must participate in the transportation program managed by the Hacienda Business Park Owners' Association. This mechanism assures that employers use consistent surveys, that employees can find out about people working with other companies who are interested in carpooling and that incentives such as preferential parking are coordinated. Further, resources can be used most effectively when employers jointly plan promotions and when all employees can utilize the shuttle bus.

The Park's Design Guidelines require that each site provide carpool preferential parking for a minimum of 5 percent of the employees. Located near building entrances, the preferential spaces are designated with signs and pavement striping, designed by the Hacienda Owners' Association.

Bicycle racks are also required to be part of each building design. Facilities for 3.5 percent of the building population are installed. Through the Park's Design Review Committee, building designs are inspected for bike rack and preferential parking locations before they are approved.

When an employer moves into the Park or a multi-tenant building begins to fill up, a transportation coordinator is appointed. The coordinator surveys employees, establishes an information center, plots employees' residences on a zip code map, meets with new employees to explain the program and helps commuters establish new ways of getting to work. The transportation coordinators meet monthly for an exchange of ideas and information.

Individual companies are also promoting ridesharing. Chabot Center, a multi-tenant building installed a transportation display case in the lobby near the elevators. Viacom Cablevision started a transportation newsletter and awards commuters of the month with $5 in coins for the vending machines. AT&T Communications set up an information table for 1 week and manned it with volunteers through the company's quality of work life program. Additionally, carpool groups were entered in a prize drawing and the winners' names were displayed on the television monitors used to update telephone operators on company bulletins. Crum & Forster Personal Insurance mentioned the Business Park Shuttle Bus in recruitment ads. Hacienda Center, a multi-tenants building, installed showers.

The Owners' Association provides a variety of support services to the company transportation coordinator. Processing the transportation survey and producing statistical reports and employee matchlists is one of the largest projects. The Park Security Guard monitors the use of the preferential parking spaces, issuing courtesy citations and arranging for towing when necessary. A manual was produced for transportation coordinators, and regular individual and group training is offered. Transit tickets are sold through the Hacienda Community Center. Additionally, nearly every issue of the Hacienda newspaper, "Pleasanton Pathways," includes an article on transportation. The paper is delivered to employees and Pleasanton residents.

The Owners' Association provides four 32-passenger shuttle buses connecting with the Bay Area Rapid Transit station during commute hours. As an incentive to those who leave their cars at home, the buses circulate the Park all day and transport employees to shops and restaurants between 11:30 a.m. and 2:00 p.m. These services are free to employees and cost the Owners' Association $350,000 per year. In a recent on-board survey, employees pointed to the shuttle's convenience and friendly drivers as their reason for riding the bus.

The Business Park has coordinated their transit service with the BART Express Bus program. In June, BART changed their routes to include the Park. Efforts were also made to coordinate the Hacienda Shuttle and Express Bus schedules to offer 10 morning and 13 afternoon trips between the Park and BART.

Hacienda Business Park has found the centralized transportation program most effective when designing promotional events. Over 300 employees from a variety of work sites attended a series of 18 carpool meetings. The groups were invited by zip code areas and were able to form carpool groups on the spot. The only expenses were the production of posters, refreshments, and $300 in cash prizes.

The community poster contest generated 28 graphic and slogan ideas, provided an opportunity to educate elected officials and newspaper reporters about the program by asking them to judge the posters, and resulted in numerous newspaper articles about the project. The cost: less than $1,000.

The largest event sponsored so far was the transportation fair, attracting 1,300 employees. There were 50 exhibitors, two active wear fashion shows, live music and over 160 donated prizes and coupons. More than 500 employees rode the Hacienda Shuttle Bus, many for the first time, over to the fair. Although the fair cost the Owners' Association $4,000 and required 1½ staff persons for 2 months, the positive employee response made the Park feel the event was well worth it. Unusual exhibits included a hot air balloon, limousines, race cars, and an electric car.

With a marketing budget of nearly $20,000, the Park provides artwork, posters, promotion items and other marketing support to employers. The emphasis has been on camera-ready art that each coordinator can reproduce on colored paper and distribute as appropriate.

The Owners' Association's IBM XT manages the data collected from the transportation survey. In addition to calculating the survey results, the computer produces mail labels targeted to specific geographic areas or commute interests, carpool matchlists, and several other reports.

With an 87 percent return, the survey results are felt to be in the 95 percent accuracy interval. The mode split was 25 percent Carpool, 3 percent transit, 2 percent vanpool, 1 percent bike and walk, and 69 percent drive alone. The majority (63 percent) of the carpools are composed of two people traveling together. Traffic and distance were the most often cited disadvantages of employees' current commutes. Fifty percent reported that they would consider an alternative commute method, especially carpooling.

In order of importance to them, employees reported that they are likely to consider carpooling if: (1) a fellow employee lived close by; (2)a car was available for emergencies; (3) the company provided a subsidy; (4) a car was available for business; or (5) they knew in advance about overtime. Other issues of concern to these employees were smoking in the pool and picking up children from child care.

As many companies relocated to Pleasanton, it was found that 40 percent lived more than 21 miles from the worksite. Geographically, the spread of employees is 23 percent live l-5 miles away, 14 percent live 6-10 miles away, and 10 percent live 16-20 miles away.

The 1985 survey showed that 25 percent of the employees are clerical, 31 percent managerial or administrative, 12 percent professional or technical, and 10 percent are in sales. Employees' perceived the need to use their cars during work hours as follows: 10 percent said never; 7 percent 'said 1 day/month; 17 percent said 1 day/week; 26 percent said 2-3 days/week; 26 percent said 4-5 days/week; and 10 percent gave no response. When asked about visitors, nearly half said they never have visitors and only 9 percent reported visitors more than twice a week.

In the future as more employers move into Hacienda, the employee make-up will change and the transportation management program is expected to be tailored to meet their needs. Special marketing to multi-tenant buildings will also be required. Managing the large number of diverse tenant programs, providing training, and responding to their individual needs will be a challenge.

More emphasis will be made on other commute alternatives besides carpooling in the next few years. Opportunities for local commuters to leave their cars at home will increase was the local transit service develops. Additionally, vanpooling opportunities will be enhanced with enlarging employment base. The shuttle service will be closely monitored and upgraded in response to employee feedback.

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